

XY-X

SERIES

OWNER'S MANUAL

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MEMO

CHAPTER 1



Using the Robot Safely

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MEMO

1 Safety Information

Industrial robots are highly programmable machines that provide a large degree of freedom in movement. To ensure correct and safe use of YAMAHA robots, carefully read this manual to make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS INCLUDED IN THIS MANUAL. Failure to take necessary safety measures or mishandling due to not observing the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot installer, operator or service personnel) including fatal accidents.

Warning information in this manual is classified into the following items.

DANGER

Failure to follow DANGER instructions will result in severe injury or death to the robot operator, bystanders or persons servicing the robot.

WARNING

Failure to follow WARNING instructions could result in severe injury or death to the robot operator, bystanders or persons servicing the robot.

CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, bystanders or persons servicing the robot, or damage to the robot and/or robot controller.

NOTE

Explains the keypoint in the operation in a simple and clear manner.

Refer to the instruction manual by any of the following methods to operate or adjust the robot safely and correctly.

1. Operate or adjust the robot while referring to the printed version of the instruction manual (available for an additional fee).
2. Operate or adjust the robot while viewing the CD-ROM version of the instruction manual on your computer screen.
3. Operate or adjust the robot while referring to a printout of the necessary pages from the CD-ROM version of the instruction manual.

It is not possible to list all safety items in detail within the limited space of this manual. Thus, it is essential that the user have full knowledge of basic safety rules and that the operator makes correct judgments on safety procedures during operation.

When exporting this robot, the warning labels and instruction manuals must be changed to export specifications.

2 Essential Caution Items

Particularly important cautions for handling or operating the robot are described below. In addition, safety information about installation, operation, inspection and maintenance is provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

(1) Observe the following cautions during automatic operation

⚠ DANGER

Serious injury will result from impact with moving robot.

- **Keep outside safeguard enclosure during automatic operation.**
- **Press the emergency stop button before entering the safeguard enclosure.**

The warning label 1 (Fig. 1-1) is attached to the robot.

- Install a safeguard enclosure to keep all personnel from entering within the movable range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install safeguards so that no one can enter inside except from doors or panels equipped with safety interlocks.
- The warning label 1 (Fig. 1-1) are supplied with the robot and should be affixed to conspicuous places on doors or panels equipped with safety interlocks.

(2) Use caution to prevent hands or fingers from being pinched or crushed.

⚠ WARNING

**Moving parts can pinch or crush.
Keep hands always from robot arms.**

Warning label 2 (Fig. 1-2) is affixed to the robot.

Use caution to prevent hands or fingers from being pinched or crushed in the robot's moving parts during transporting the robot or teaching, etc.



Fig. 1-1 Warning label 1

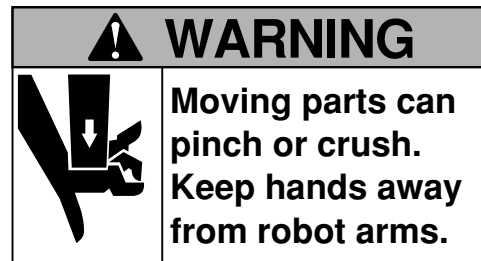


Fig. 1-2 Warning label 2

- (3) Follow the instructions listed on warning labels and in this manual.

⚠ WARNING

Improper installation or operation can result in serious injury. Read the Instruction Manual and all warning labels before operation.

The warning label 3 (Fig. 1-3) is attached to the robot.

- Be sure to read the warning labels and this manual carefully and make sure to thoroughly understand the contents before attempting installation and operation of the robot.
- Before starting robot operation, be sure to reread the procedures and cautions related to the work as well as the descriptions in this chapter (Chapter 1. “Using the Robot Safely”).
- Never install, adjust, inspect, service or operate the robot in any manner that does not comply with the instructions in this manual.



Fig. 1-3 Warning label 3

- (4) Do not use the robot in environments containing inflammable gas, etc.

⚠ WARNING

- This robot is not designed for operation in environments where inflammable or explosive substances are present.
 - Do not use the robot in environments containing inflammable gas, dust or liquids.
Explosions or fire might otherwise result.
-

- (5) Do not use the robot in locations possible subject to electromagnetic interference, etc.

⚠ WARNING

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunctions might otherwise occur.

- (6) Use caution when releasing the brake for the Z-axis (vertical axis).

⚠ WARNING

The Z-axis will drop when the brake is released, creating a hazardous situation.

- Press the emergency stop button and prop up the Z-axis with a support stand, etc., before releasing the brake.
 - Be careful not to let your body get caught between the Z-axis and installation base, etc., when releasing the brake to perform direct teaching.
-

- (7) Provide safety measures for end effector (gripper, etc.)

⚠ WARNING

- End effectors must be designed and manufactured so that they create no hazards (for example, a workpiece that comes loose) even if power (electricity, air pressure, etc.) is shut off or a power fluctuation occurs.
 - If there is a possible danger that the object gripped by the end effector may fly off or drop, then provide appropriate safety protection taking into account the object size, weight, temperature and chemical properties.
-

(8) Movement of Z-axis at controller power shut off and emergency stop (for ZAS)**⚠ WARNING**

The Z-axis will start to rise when the controller power is shut off, the PLC power is shut off, the program is reset, emergency stop is applied, and when the supply of air to the Z-axis air cylinder's solenoid valve is started.

- Take care not to pinch or crush hands, etc., in the Z-axis moving sections.
 - If there are any interferences in the Z-axis' upward travel path, reevaluate the robot position, except for emergencies.
-

(9) Pay attention to interference of Z-axis with peripheral devices (for ZAS)**⚠ WARNING**

If the Z-axis interferes with a peripheral device and stops, there is a risk of pinching hands, etc., when the interfering object is removed as the Z-axis will suddenly move.

- Turn the controller power OFF and stop the air supply before removing the interfering object.
 - The Z-axis will naturally drop, so prop it up with a support stand, etc., before stopping the air supply.
-

(10) Z-axis movement when air supply is stopped**⚠ WARNING**

The Z-axis will drop when the air supply is stopped, creating a hazardous situation.

Prop up the Z-axis with a support stand, etc., before turning the controller power OFF and stopping the air supply.

(11) Use caution when disassembling and replacing the pneumatic devices**⚠ WARNING**

If the pneumatic devices are disassembled or replaced while the air is supplied, the parts or air could scatter.

- Turn the controller power OFF, stop the air supply and release all residual pressure from the pneumatic devices before starting work.
 - The Z-axis will naturally drop, so prop it up with a support stand, etc., before stopping the air supply.
-

(12) Use caution when disassembling and replacing the motor

⚠ WARNING

When disassembling or assembling the motor for a ball-screw drive type robot, a strong magnetic attraction force will be present between the motor stator (fixed coil) and rotor (rotating magnet), causing a risk of pinching hands, etc.

A YAMAHA-trained operator must carry out this work using the YAMAHA-recommended jigs.

(13) Use caution when removing the Z-axis brake

⚠ WARNING

The Z-axis will naturally drop when the brake is removed, causing a hazardous situation.

- Prop up the Z-axis with a support stand, etc., before turning the control power OFF and removing the brake.
 - Be careful not to let your body get caught between the Z-axis drive section and Z-axis installation base, etc.
-

(14) Take the following safety precautions during inspection of the controller

⚠ WARNING

- If the terminals or connectors on the outside of the controller must be touched during inspection, etc., always first turn the controller power OFF and the power source to prevent possible electrical shock.
 - Refer to the "YAMAHA Robot Controller Instruction Manual" for precautions on handling the controller. Never touch any internal parts of the controller.
-

(15) Consult YAMAHA for corrective action when the robot is damaged or malfunctions occur.

⚠ WARNING

If any part of the robot is damaged or any malfunction occurs, continuing the operation may be very dangerous. Please consult your YAMAHA sales office or dealer for corrective action.

| Damage or Trouble | Possible Danger |
|--|--|
| Damage to machine harness or robot cable | Electrical shock, malfunction of robot |
| Damage to exterior of robot | Flying outward of damaged parts during robot operation |
| Abnormal operation of robot (positioning error, excessive vibration, etc.) | Malfunction of robot |
| Z-axis brake trouble | Dropping of load |

(16) Use caution not to touch the controller rear panel cooling fan

⚠ WARNING

- Injury may occur from coming into contact with the cooling fan while it is rotating.
 - When removing the fan cover for inspection, first turn OFF the controller and make sure that the fan has stopped.
-

(17) Be careful not to touch the motor or speed reduction gear casing when hot.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched.

- Before handling these parts during inspection or servicing, turn the controller power OFF, wait for a while and check that the part has cooled.
-

(18) Do not remove, alter or stain the warning labels

⚠ WARNING

If the warning labels are removed or difficult to see, then essential precautions might not be taken resulting in accidents.

- Do not remove, alter or stain the warning labels on the robot.
 - Do not allow the warning labels to be hidden by devices installed onto the robot by the user.
 - Provide proper lighting so that the symbols and instructions on the warning labels can be clearly seen even from outside the safeguard enclosure.
-

(19) Protective connections

⚠ WARNING

Be sure to ground the robot and controller to prevent electrical shock.

(20) Be sure to make correct parameter settings - Part 1

⚠ CAUTION

Always input the correct parameters matching the payload and stroke (working envelope) before operating the robot.

(21) Be sure to make correct parameter settings - Part 2

⚠ CAUTION

When using a rotary axis (RF, RH, etc.) the robot must be operated with the tolerable moment of inertia and correct acceleration coefficients according to the tip mass and moment of inertia. If these are not correct, the drive unit service life may end prematurely, and damage to robot parts or residual vibration during positioning may result.

(22) Do not use the robot for tasks requiring motor thrust.

⚠ CAUTION

Avoid using the belt-driven type robots for tasks that utilize motor thrust (press fitting, burr removal, etc.).
These tasks may cause malfunctions in the robot.

3 Special Training for Industrial Robot Operation

Companies or factories using industrial robots must make sure that every person, who handles the robot such as for teaching, programming, movement check, inspection, adjustment and repair, has received appropriate training and also has the skills needed to perform the job correctly and safely.

Since YAMAHA Cartesian Robot XY Series falls under the industrial robot category, the user must observe local regulations and safety standards for industrial robots, and provide special training for every person involved in robot-related tasks (teaching, programming, movement check, inspection, adjustment, repair, etc.).

4 Robot Safety Functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power.

(2) Overheat detection

This detects an abnormal rise in the controller driver temperature and shuts off the servo power.

If an overload or overheat error occurs, take the following measuring.

1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

(3) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation. Note that the working envelope is the area limited by soft limits.

(4) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movable range.

No mechanical stopper is provided on the R-axis.

Note that the movable range is the area limited by the mechanical stoppers.

(5) Z-axis (vertical axis) brake

An electromagnetic brake is installed on the Z-axis to prevent the Z-axis from dropping when the servo power is shut off. This brake is working when the controller power is OFF or if the Z-axis servo is OFF even when the controller power is ON.

The Z-axis brake can be released by means of the programming unit or by a command in the program when the controller power is ON.

⚠ WARNING

The Z-axis will drop when the brakes are released, creating a hazardous situation.

- **Press the emergency stop button and prop up the Z-axis with a support stand, etc., before releasing the brake.**
 - **Be careful not to let your body get caught between the Z-axis and installation base, etc., when releasing the brake to perform direct teaching.**
-

5 Safety Measures for the System

When the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Appropriate safety measures must be taken on the part of the system manufacturer according to the individual system.

The system manufacture should provide a proper instruction manual for safe, correct operation and servicing of the system.

6 Trial Run

After making installations, adjustments, inspections, maintenance or repairs to the robot, carry out trial run using the following procedures.

- (1) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off the movable range in place of the safeguard enclosure, and observe the following points.
 1. Use sturdy, stable posts that will not fall over easily.
 2. The rope or chain should be easily visible by everyone around the robot.
 3. Place a sign to keep the operator or other personnel from entering the movable range.

- (2) Check the following points before turning the controller ON.
 1. Is the robot securely and correctly installed?
 2. Are the electrical connections to the robot correct?
 3. Are items such as air pressure correctly supplied?
 4. Is the robot correctly connected to peripheral devices?
 5. Have safety measures (safeguard enclosure, etc.) been taken?
 6. Does the installation environment meet the specified standards?

- (3) After the controller power is turned ON, check the following points from outside the safeguard enclosure.
 1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
 2. Does each axis move as intended within the soft limits?
 3. Does the end effector move as intended?
 4. Are the signal transmissions to the end effector and peripheral devices correct?
 5. Does emergency stop work?
 6. Are the teaching and playback functions normal?
 7. Are the safeguard enclosure and interlock working as intended?
 8. Does the robot move correctly during automatic operation?

7 Work Within the Safeguard Enclosure

- (1) When work is required in the safeguard enclosure, always turn the controller power OFF and place a sign indicating that the robot is being adjusted or serviced in order to keep any other personnel from touching the controller power switch or operation panel, except for the following cases.
 - 1) Soft limit settings
 - 2) Teaching

For item 1), follow the precautions and procedure for each section.

To perform item 2), refer to the description in (2) below.

- (2) Teaching

When performing teaching within the safeguard enclosure, comply with the instructions listed below.

 - 1) Check or perform the following points from outside the safeguard enclosure.
 1. Make sure that no hazards are present within the safeguard enclosure by a visual check.
 2. Check that the programming unit MPB or TPB operates correctly.
 3. Check that no failures are found in the robot.
 4. Check that emergency stop works correctly.
 5. Select teaching mode and prohibit automatic operation.
 - 2) Never enter the movable range of the robot while within the safeguard enclosure.

8 Automatic Operation

- (1) Check the following before starting automatic operation.
 1. No one is within the safeguard enclosure.
 2. The programming unit or tools, etc., are in their specified location.
 3. The alarm or error lamps, etc., on the robot and peripheral devices do not flash.
 4. The safeguard enclosure is securely installed with safety interlocks, etc., actuated.

- (2) Observe the following during automatic operation or in cases where an error occurs.
 - 1) After automatic operation has started, check the operation status and warning lamps to ensure that the robot is in automatic operation.
 - 2) Never enter the safeguard enclosure during automatic operation.
 - 3) If an error occurs in the robot or peripheral devices, observe the following procedures before entering the safeguard enclosure.
 1. Press the emergency stop button to set the robot to emergency stop.
 2. Place a sign on the start switch indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

9 Adjustment and Inspection

⚠ WARNING

Do not attempt any installation, adjustment, inspection or maintenance unless described in this manual. Unexpected accidents or troubles may otherwise result.

10 Repair and Modification

⚠ WARNING

Do not attempt any repair, part replacement or modification unless described in this manual. These matters require technical knowledge and skills, and may also involve work hazards.

11 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:

- 1) After 18 months (one and a half year) have elapsed from the date of shipment
- 2) After one year has elapsed from the date of installation
- 3) After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases

- 1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)
- 2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).
- 3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

- 1) Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.
- 2) Troubles caused by procedures prohibited in this manual.
- 3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
- 4) Use of any other than genuine parts and specified grease and lubricants.
- 5) Incorrect or inadequate maintenance and inspection.
- 6) Repairs by other than authorized dealers.

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YAMAHA MOTOR CO., LTD. SOLE LIABILITY SHALL BE FOR THE DELIVERY OF THE EQUIPMENT AND YAMAHA MOTOR CO., LTD. SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES (WHETHER ARISING FROM CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY). YAMAHA MOTOR CO., LTD. MAKES NO WARRANTY WHATSOEVER WITH REGARD TO ACCESSORIES OR PARTS NOT SUPPLIED BY YAMAHA MOTOR CO., LTD.

12 CE Marking

Refer to the following YAMAHA Robot Controller Instruction Manuals for details on the related CE Marking for export to or use in EU regions.

- QRCX-E Instruction Manual
- ERCX/SRCX/DRCX compatible with CE marking supplement manual

CHAPTER 2



Product Outline

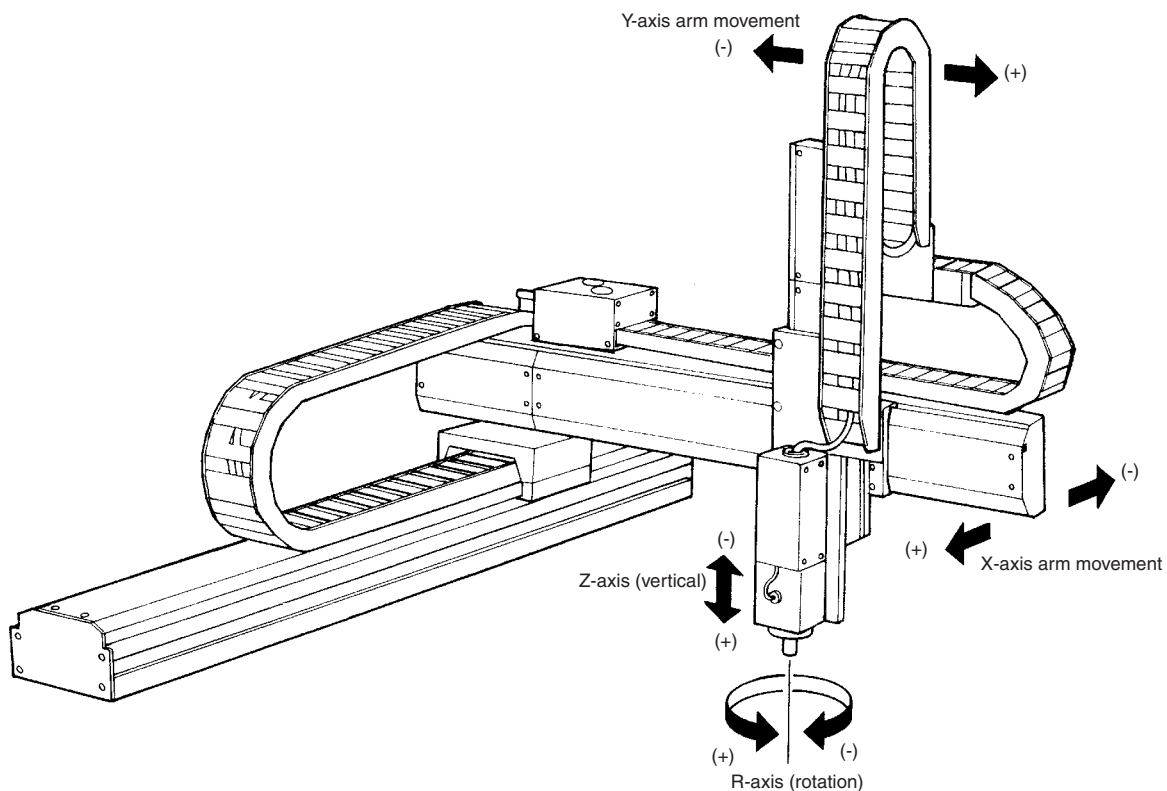
| | | |
|---|--------------------------|-----|
| 1 | Robot | 2-1 |
| 2 | Names of each part | 2-2 |
| 3 | Robot Controller | 2-7 |

MEMO

1 Robot

The robot is configured of the standard function X/Y axes (horizontal cartesian slide) and optional function Z-axis (vertical slide) and R-axis (rotation).

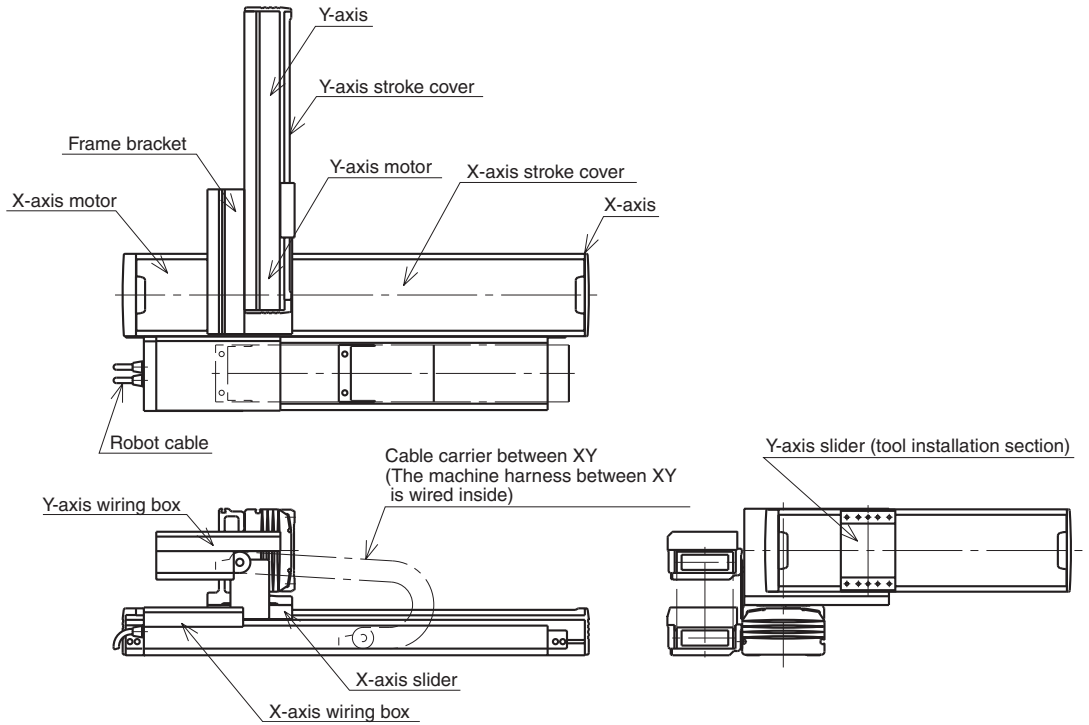
These configuration axes can move in the following manner. High-accuracy and high-speed work can be carried out over a wide range by installing work tools. (+) and (-) indicate the jog key movement directions. (Default settings)



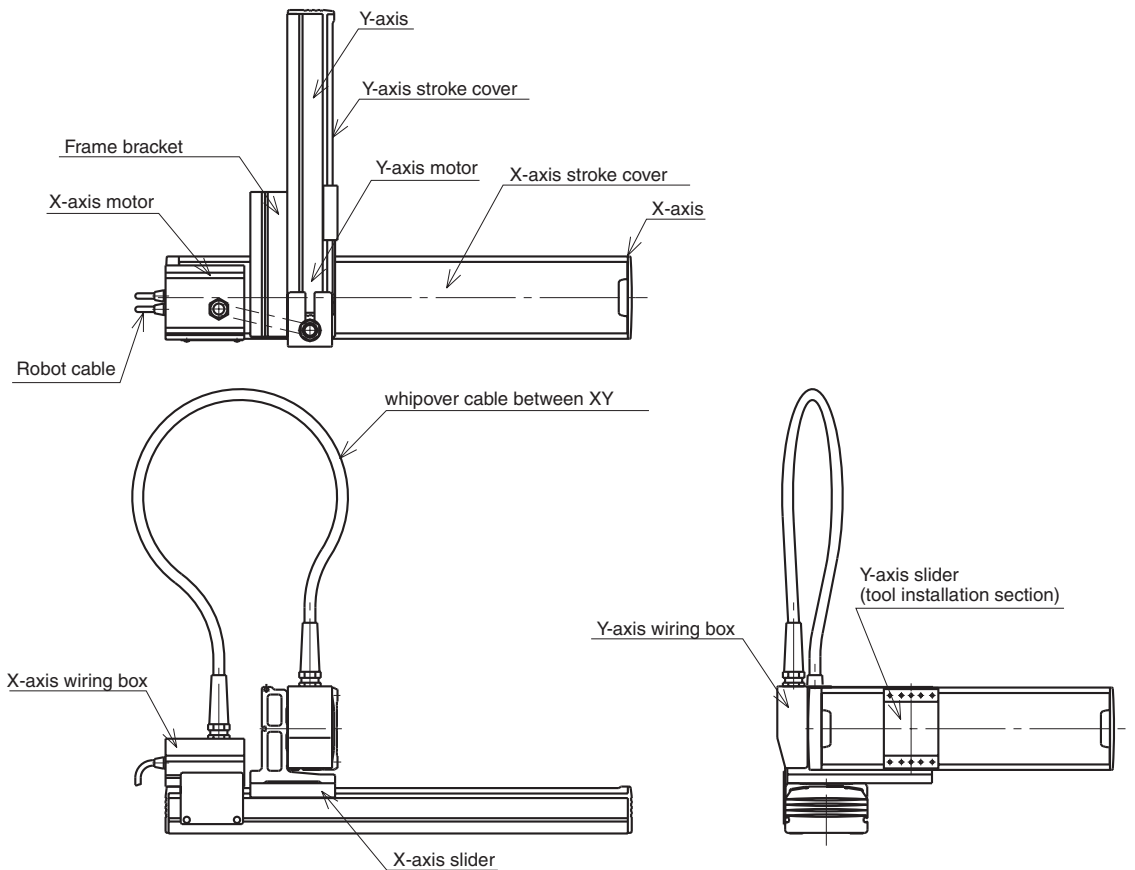
Robot movements (with ZR axes)

2 Names of each part

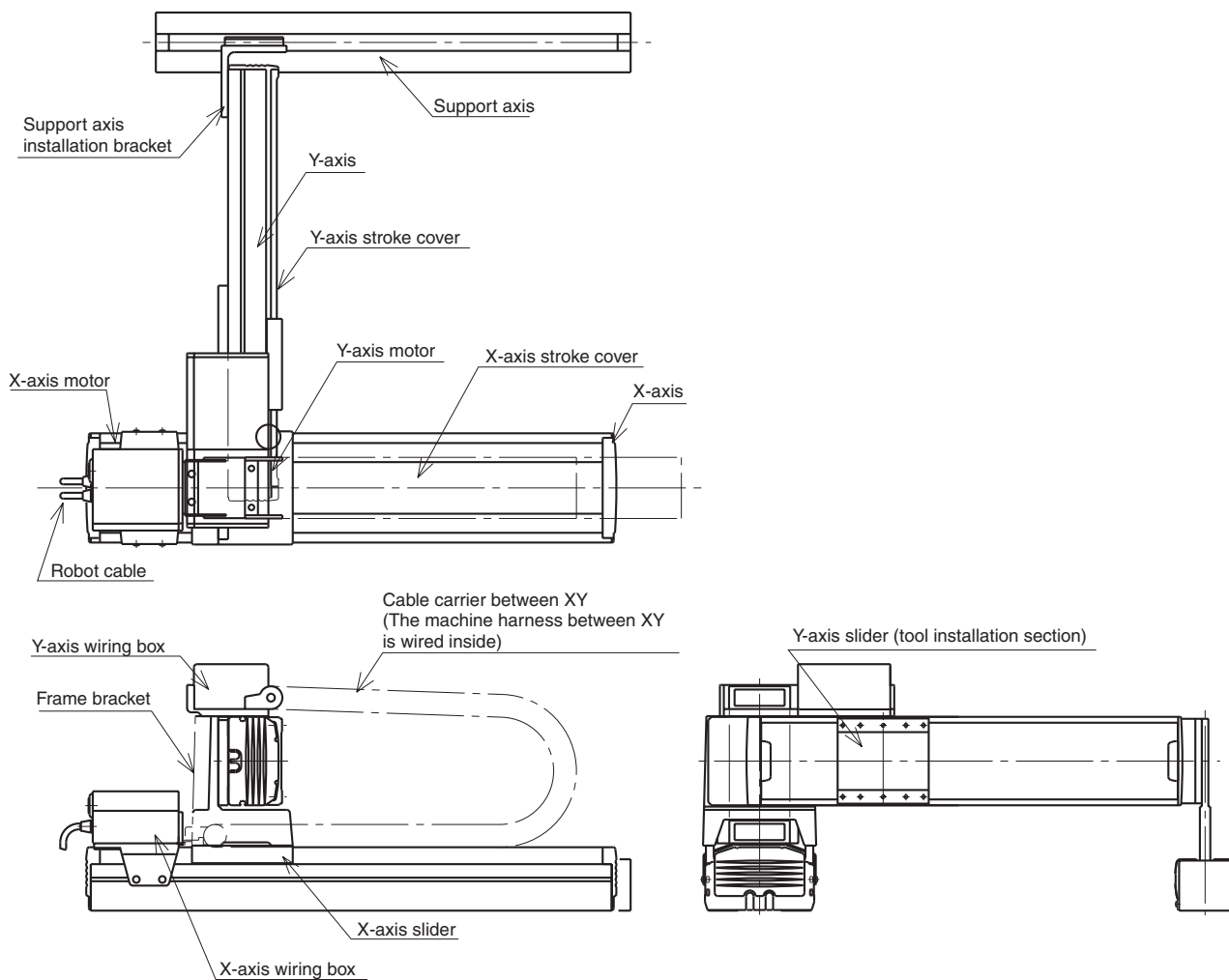
■ Arm type with cable carrier



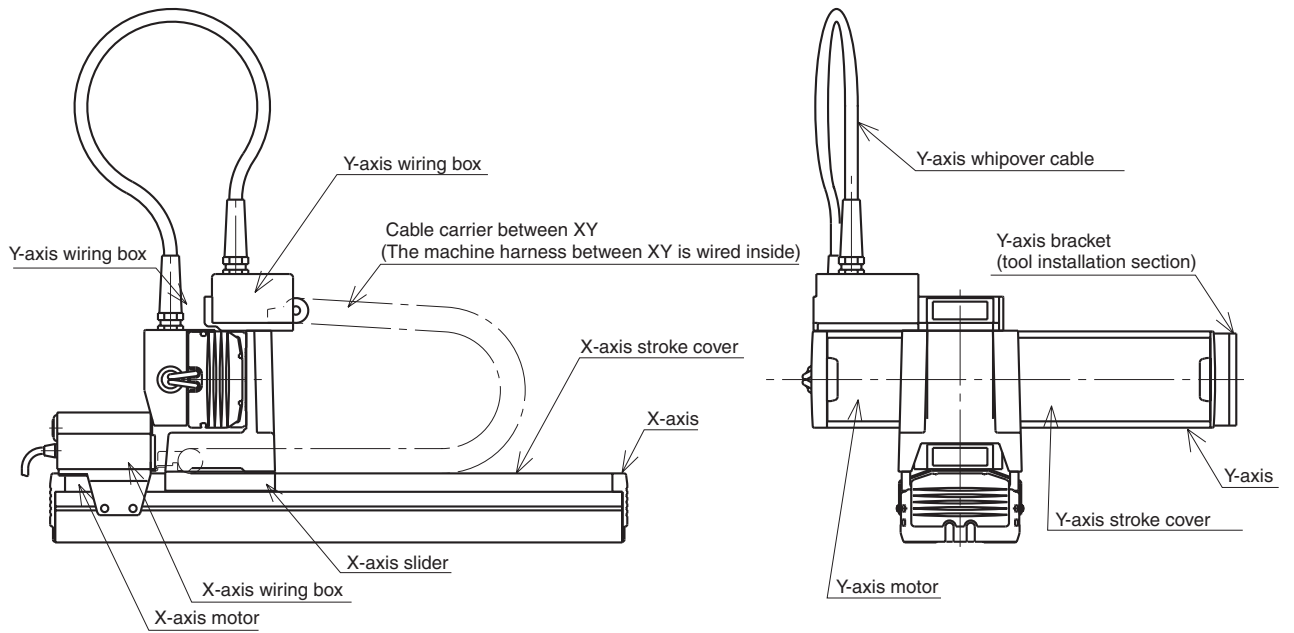
■ Arm type with whipover cable



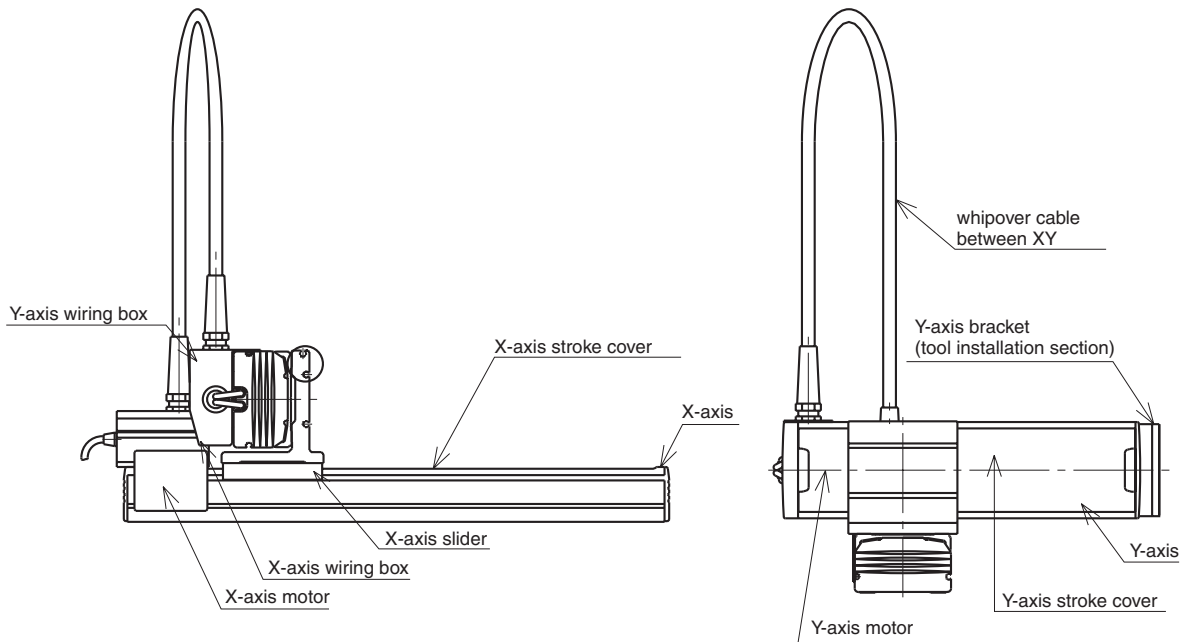
■ Gantry type



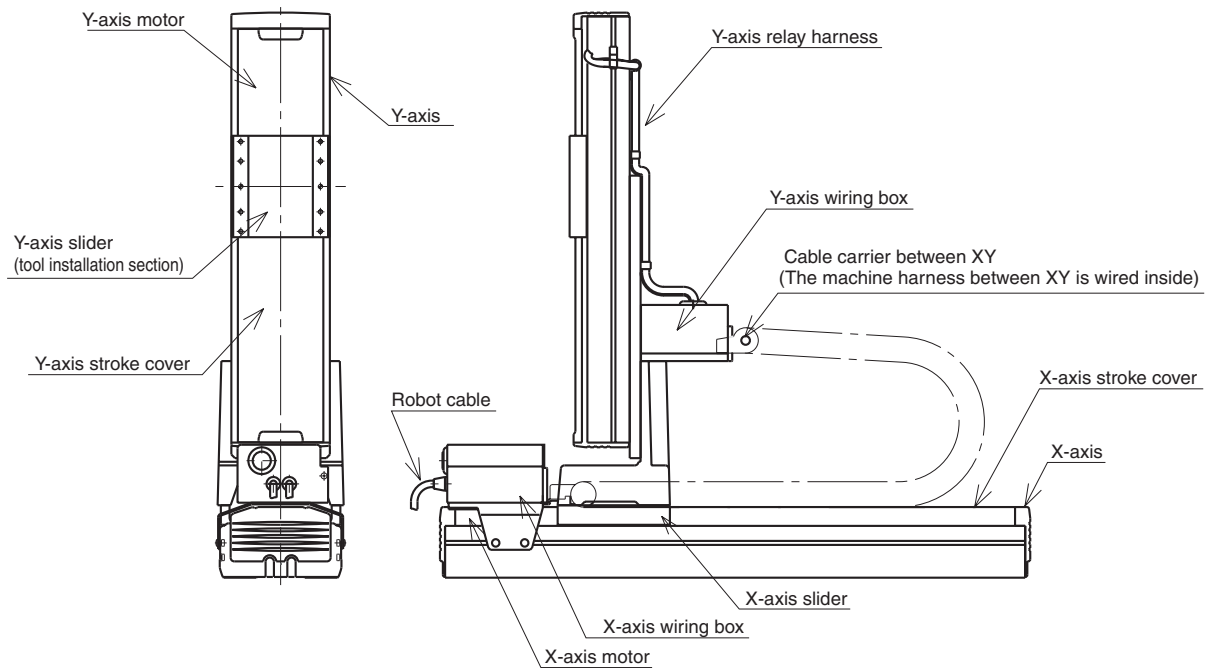
■ Moving arm type (with cable carrier)



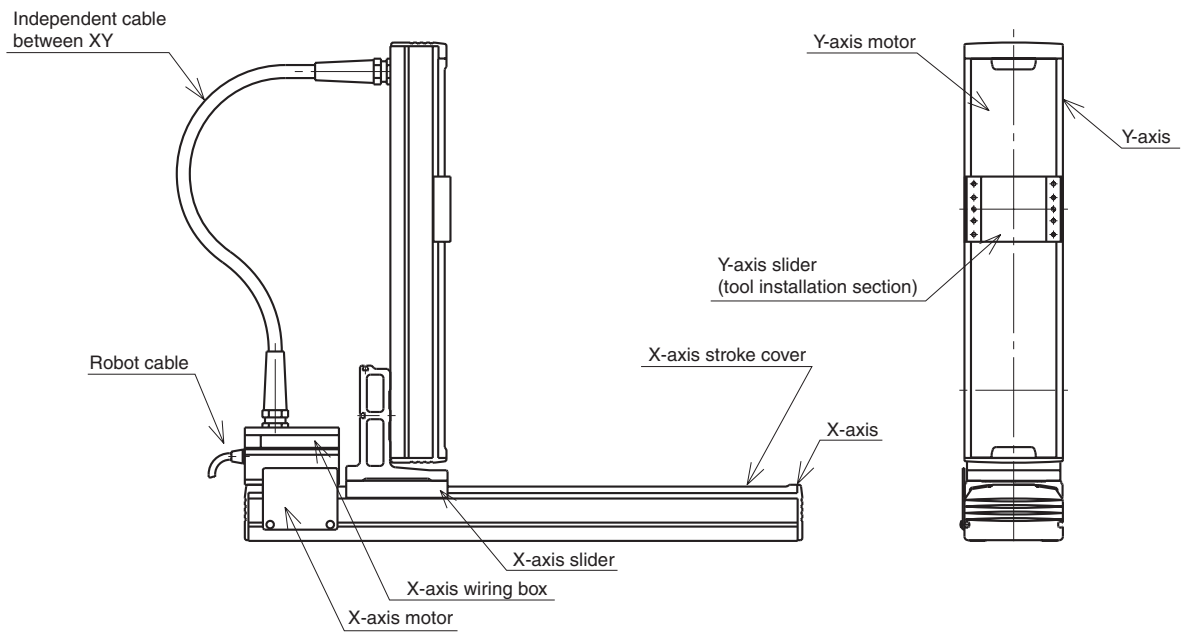
■ Moving arm type (with whipover cable)



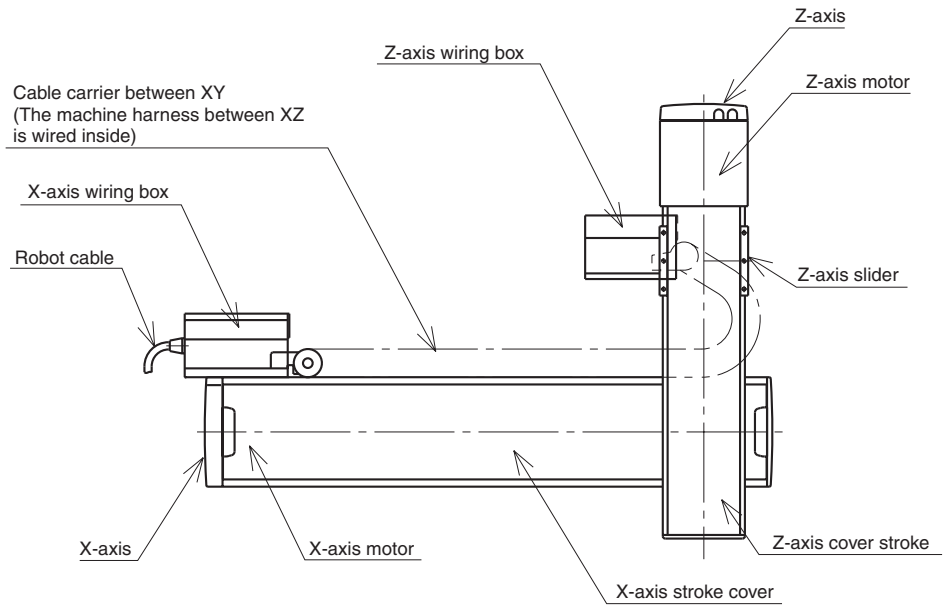
■ Pole-type with cable carrier



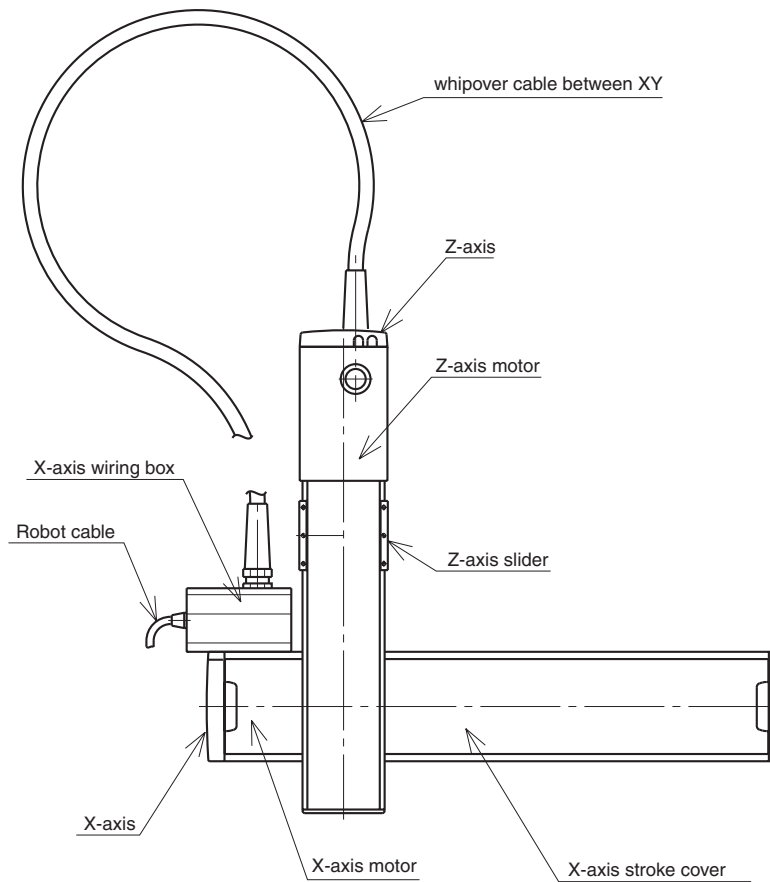
■ Pole-type with whipover cable



■ XZ-type with cable carrier



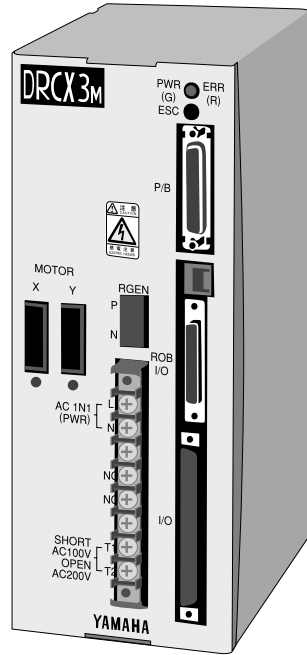
■ XZ-type with whipover cable



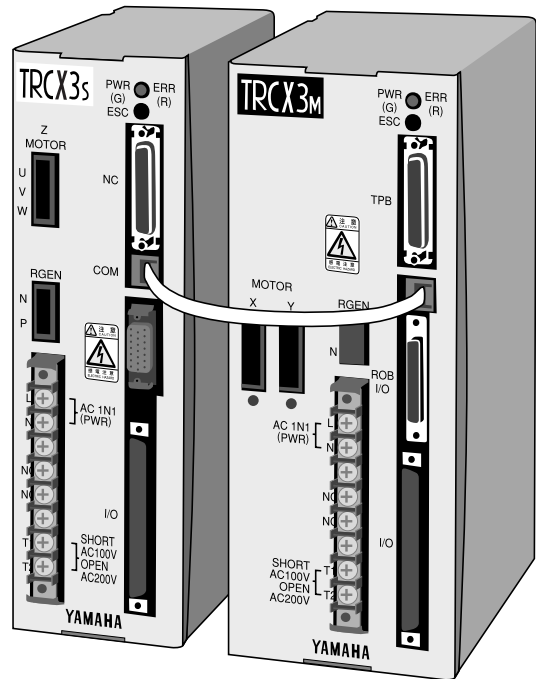
3 Robot Controller

A RCX40, QRCX, TRCX or DRCX Series robot controller is enclosed with the XY-X Series according to the user's order.

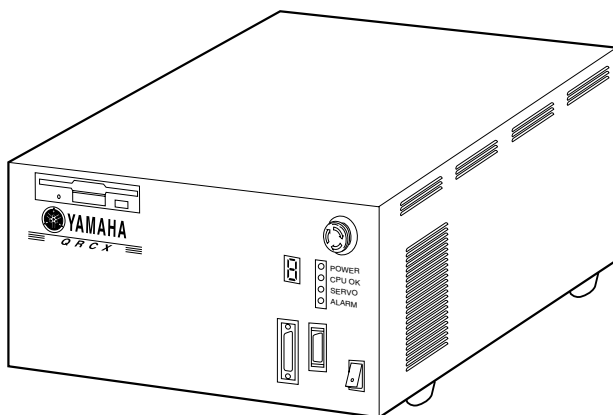
Refer to the separate "YAMAHA Robot Controller Instruction Manual" for details on the robot controller.



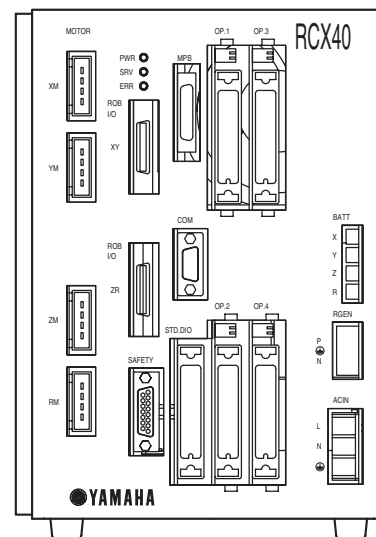
DRCX



TRCX



QRCX



RCX40

Robot Controller

MEMO

CHAPTER 3

Preparing the Robot

| | | |
|-------|--|------|
| 1 | Robot Installation Environment | 3-1 |
| 2 | Unpacking the Robot | 3-2 |
| 3 | Checking the Product | 3-3 |
| 4 | Transporting the Robot | 3-5 |
| 5 | Installation | 3-7 |
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MEMO

1 Robot Installation Environment

⚠ WARNING

Avoid installing the robot in locations where the ambient conditions may exceed the allowable ambient temperature or relative humidity, or in environments where excessive moisture, corrosive gas, metallic powder or dust is generated.

Malfunctions, failures or short circuits may otherwise result.

⚠ WARNING

- This robot is not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids.

Explosions or fire might otherwise result.

⚠ WARNING

Do not use the robot in locations subject to excessive vibration. Robot installation bolts may otherwise become loose causing the robot to fall over.

⚠ CAUTION

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference.

Malfunctions might otherwise occur.

Always install the robot in the following type of environment.

| Item | Specifications |
|-------------------------------------|---|
| Allowable ambient temperature | 0 to 40°C |
| Allowable ambient relative humidity | 35 to 80%RH (with no dew condensation) |
| Altitude | 0 to 1000m above mean sea level |
| Ambient environment | Avoid installing near water, cutting water, oil, dust, metallic chips or organic solvent. Avoid installing near corrosive gas or corrosive materials. Avoid installing in atmosphere containing inflammable gas, dust or fluid. Avoid installing near objects causing electromagnetic interference, electrostatic discharge or radio frequency interference. |
| Vibration | Do not subject robot to impact or vibration. |
| Air supply pressure, etc. | Supply clean dry air, that does not contain deteriorated compressor oil, etc., at a pressure within 0.58MPa (6.0kgf/cm ²). The air filter filtering degree must be 40µm or less. |
| Working space | Allow sufficient space so that work (teaching, inspection, repairs, etc.) can be carried out safely. |

Refer to the “YAMAHA Robot Controller Instruction Manual” for details on the controller installation conditions.

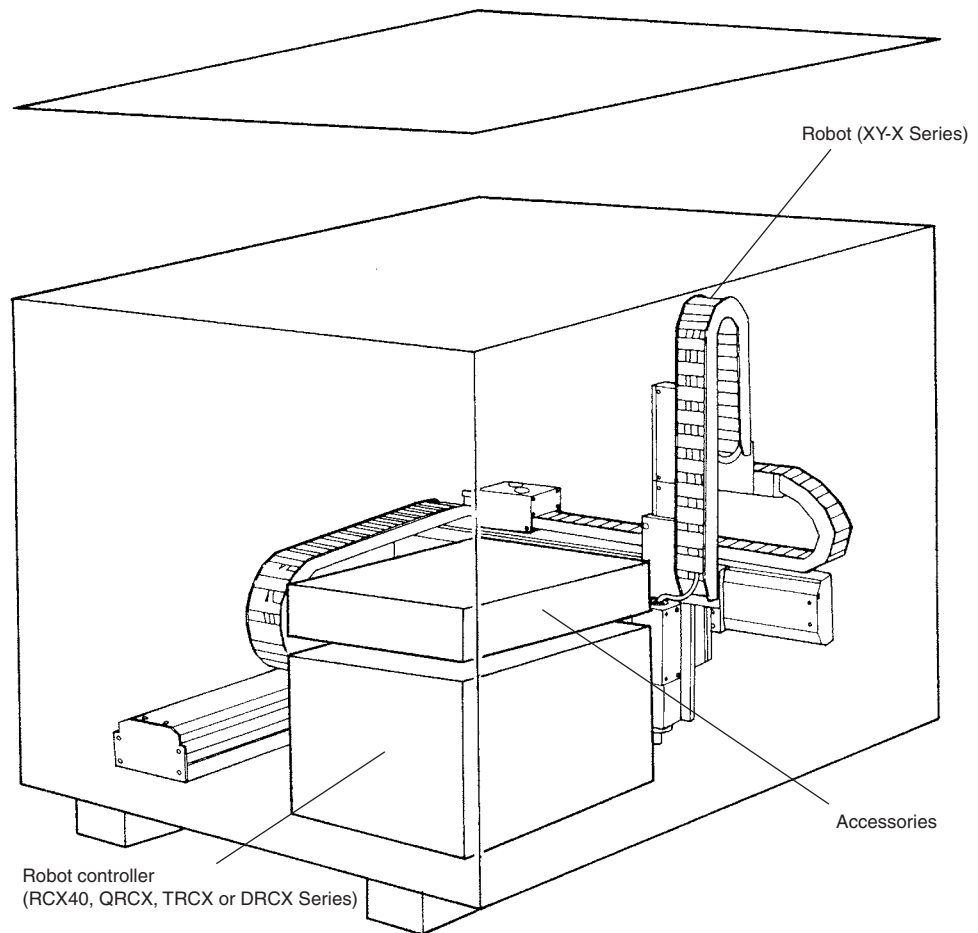
2 Unpacking the Robot

⚠ WARNING

The robot and robot controller are heavy. Take care not to drop these parts or damage the devices while unpacking the packages.

The packages are divided into the robot (XY-X Series), robot controller (RCX40, QRCX, TRCX or DRCX Series) and accessories according to the items ordered by the user.

Carefully unpack the packages while taking care not to damage the devices.



Example of packaging state

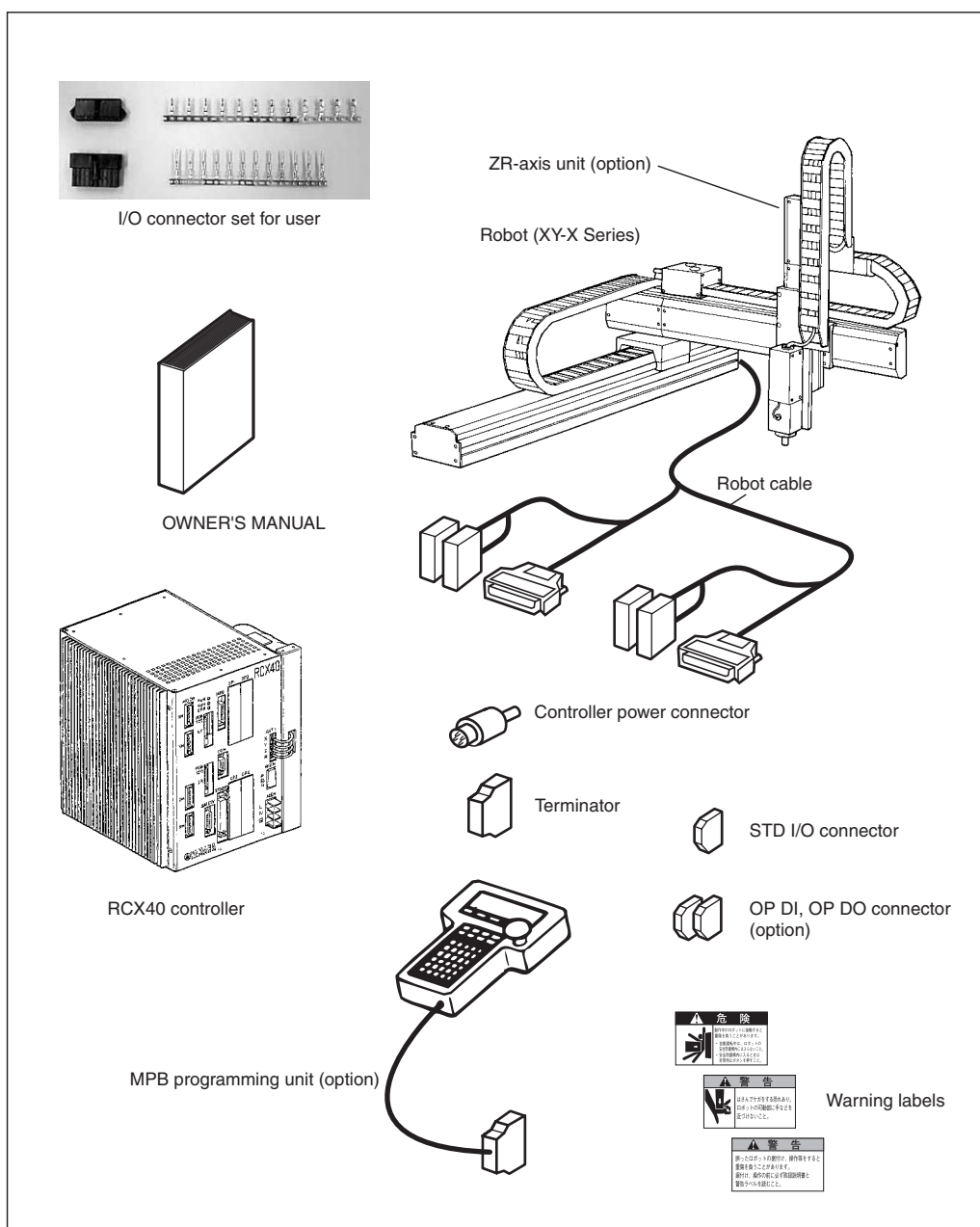
3 Checking the Product

CAUTION

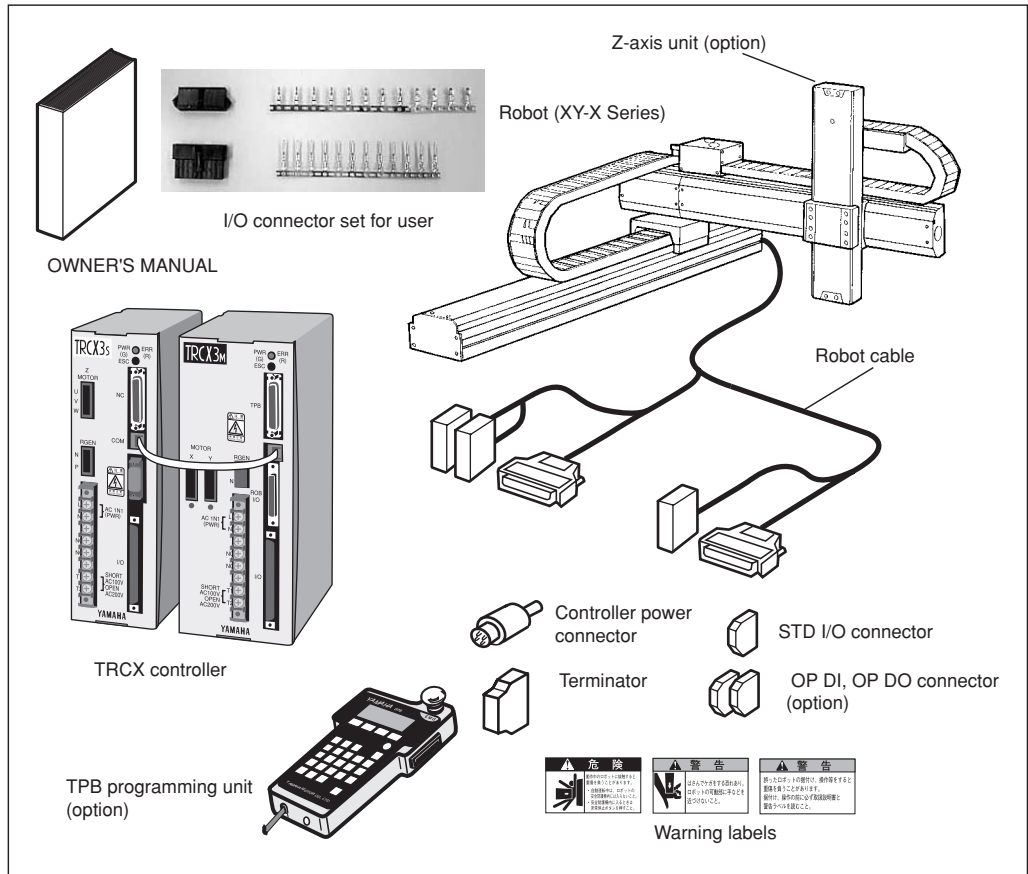
Contact your YAMAHA dealer immediately if any parts are missing or have been damaged during transportation.

After unpacking, check the state of the components and the product. An example of the common combination of components is shown below. Check the products according to the actual order.

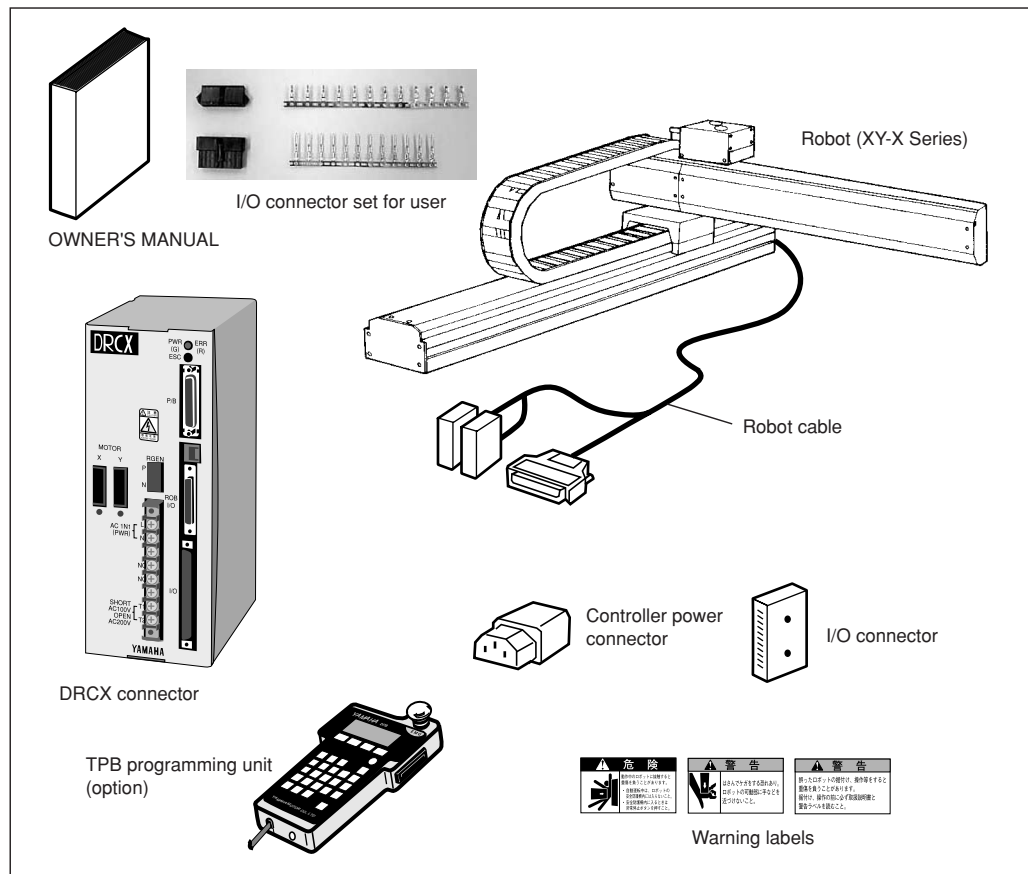
Example of combination with RCX40 controller



Example of combination with TRCX controller



Example of combination with DRCX controller



4 Transporting the Robot

⚠ WARNING

Serious injury may occur if the robot being transported falls and pins someone under it.

- Use a hoist and rope with transporting capacity strong enough to support the robot weight.
 - Make sure the rope stays securely on the hoist hook.
 - Remove all loads attached to the robot end. If any load is still attached, the robot balance may shift while being transported, and the robot may topple over causing accidents.
 - Always wear a safety helmet, safety shoes and gloves during this work.
 - When transporting the robot by equipment such as a forklift, which requires a license, only properly qualified personnel may operate such equipment. The equipment and tools used for transporting the robot should be serviced daily.
-

⚠ WARNING

Hands and fingers could get caught and serious injury could result if the slider moves while transporting the robot.

Accidents could also result if the weight balance shifts and the robot drops, etc.

- Fix the slider with a rope, etc., to prevent movement during transportation.
 - Do not place fingers between frame and cover during transportation.
 - Do not tilt the robot during transportation.
-

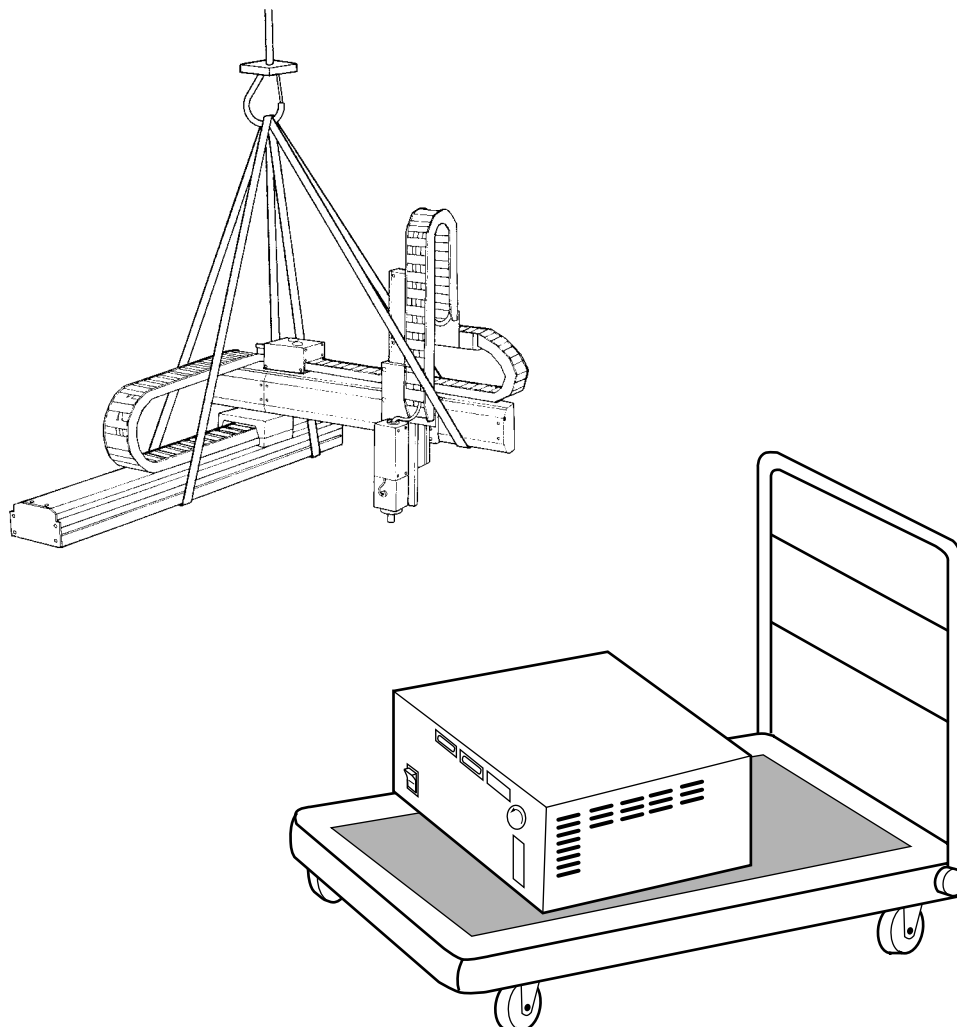
⚠ WARNING

Observe the following precautions when temporarily installing the robot. Failure to observe these could cause injuries to hands or fingers if the robot tilts over.

- Always fix the robots with bolts even when only temporarily installing the robot.
 - When temporarily installing the arm type without using bolts, set a spacer under the arm, etc., to prevent the robot from tilting over. Make sure that the spacer has sufficient strength and stability.
 - The pole-type robot's stability is especially poor, so take special care to prevent tilting during temporary installation.
-

Chapter 3 Preparing the Robot

Use of a hoist, dolly or forklift is recommended for transporting the robot or controller. Use sufficient caution when transporting robots with a long stroke or large payload as they are heavy.



5 Installation

5-1 Installation base

⚠ WARNING

If the installation base is not sufficiently rigid and stable, vibration (resonance) may occur during operation and adversely affect the robot work. In worst cases the robot might even fall over causing a serious accident.

⚠ CAUTION

If the installation surface accuracy is insufficient, the robot positioning accuracy and machine life may drop, and noise may be generated.

- 1) Select an installation base that has sufficient rigidity and stability to withstand the robot (including tool) and workpiece weight and the reaction generated during operation.
- 2) The installation base surface must be machined to a flatness within $\pm 0.05\text{mm}/500\text{mm}$.
- 3) If there is a clearance between the installation base and robot frame when the robot is set on the base, insert suitably thick shims in the clearance to prevent stress from being applied on the robot frame.
- 4) Avoid fixing the robot onto the installation base with less than the specified number of bolts, or installing only one end of the robot. Failure to observe this could lead to an increase in robot vibration and decrease in positioning accuracy.

5-2 Installing the Robot

Always observe the safety precautions and the following procedures to ensure that the robot is correctly and safely installed.

⚠ WARNING

- **Take care not to pinch hands, etc., when removing the hoist belt from the X-axis.**
 - **The robot could tilt over if the hoist belt comes undone and if the balance is lost. Prevent tilting by suspending the tilting section with a hoist or by using spacers, etc.**
-
- 1) Tap or hole is machined into the installation base where the robot is to be secured.
Refer to the XY-X Series catalog for the machining dimensions and positions.
 - 2) Fix the installation base at the specified position.
Securely fix the installation base so that it will not sway during robot operation. (Depending on the installation place or installation base shape, this step may be carried out after the robot is fixed onto the installation base.)
 - 3) Using a hoist, carefully place the robot onto the installation base.
 - 4) Remove the hoist belt from the Robot.
 - 5) Install the robot referring the explanation for each robot in Chapter 6 and following.

6 Protective connections

⚠ WARNING

Be sure to ground the robot and controller to prevent electrical shock.

⚠ WARNING

Turn the controller power OFF before starting connecting the ground.

The ground terminal position differs for each robot. Refer to the explanation for each robot in Chapter 6 and following for details.

- 1) Provide a terminal marked “PE” as the protective conductor for the entire system, and connect to an external protective conductor. Also securely connect the ground terminal on the robot base to the protective conductor.

(Symbol 417-IEC-5019)



- 2) When the end effector uses an electrical device which, if it malfunctions, might make contact with the power supply, the user must provide proper grounding on his own responsibility. The XY-X series robots do not have a ground terminal for this purpose.
- 3) For details on protective bonding on the robot body to comply with CE marking, follow the instructions on protective bonding explained in the "YAMAHA QRCX-E robot controller owner's manual".

7

Connecting the Robot Cables

⚠ WARNING

1. The robot cable is the most important cable for controlling the robot. If the connector is insufficiently connected and there are pin contact faults, the robot could malfunction. Confirm that each connector is securely connected before turning the controller power ON.
 2. Arrange the connected cables so that they will not get in the way of robot movements or the operator's operations. Make sure that excessive load is not applied on the connector due to pulling of the cables.
-

⚠ WARNING

- Before connecting the cables, check that there are no bends or breaks in the robot cable connector pins and that the cables are not damaged. Bent or broken pins or cable damage may cause robot malfunctions.
 - Turn the controller power OFF before connecting the controller and robot cable.
-

⚠ WARNING

With the RCX40, QRCX and TRCX4 controllers, the motor connectors XM and ZM, YM and RM and Robot I/O connectors XY and ZR have the same shape. Take special care when connecting as incorrect connections could cause malfunctions.

⚠ WARNING

With the TRCX3 controller, the motor connectors XM and ZM have the same shape. Take special care when connecting as incorrect connections could cause malfunctions.

⚠ WARNING

- If the connector is insufficiently connected and there are pin contact faults, the robot could malfunction. Confirm that each connector is securely connected before turning the controller power ON.
 - Before turning on the controller, check that the robot I/O connector is securely attached.
 - Make sure that excessive load is not applied on the connector due to pulling of the robot cables.
-

⚠ WARNING

Arrange the robot cable so that it will not get in the way of robot movements. Do not set the area where the robot cable interferes with the load on the robot tip as the working envelope. If the robot's moving sections interfere with the cable, the robot cable could be damaged and malfunctions could occur.

⚠ WARNING

Arrange the connected robot cable so that it will not get in the way of operator's operations. The operator could trip on the robot cable and be injured.

⚠ WARNING

When connecting the robot cable, insert the robot cable connector straight into the mating connector on the controller. Inserting the connector while tilted might cause the pins to make poor contact, causing robot malfunction and the connector itself might even break.

⚠ CAUTION

These connectors all work in only one direction. Take a good look at the connector shape before trying to attach it. Connecting the wrong way may damage the connectors.

The robot cable is connected beforehand to the XY Series robot side. Correctly install the other end of the robot cable to the robot controller. For details on connections to the robot controller, refer to 7-1 to 7-4.

7-1 Connecting with the DRCX controller

⚠ WARNING

When connecting the robot cable, insert the robot cable connector straight into the mating connector on the controller. Inserting the connector while tilted might cause the pins to make poor contact, causing robot malfunction and the connector itself might even break.

⚠ CAUTION

These connectors all work in only one direction. Take a good look at the connector shape before trying to attach it. Connecting the wrong way may damage the connectors.

- 1) Prepare the required tools.
Precision phillips-head screwdriver.
- 2) While referring to Table 3-1 and Fig.3-1, securely insert the motor connector into the correct position on the controller until a click is heard.
- 3) While referring to Table 3-1 and Fig.3-1, insert the robot I/O cable into the correct position on the controller.
- 4) Use the precision phillips-head screwdriver to tighten the robot I/O connector screws.

Table 3-1

| Robot cable | DRCX |
|-------------|---------|
| XM | MOTOR X |
| YM | MOTOR Y |
| XY | ROB I/O |

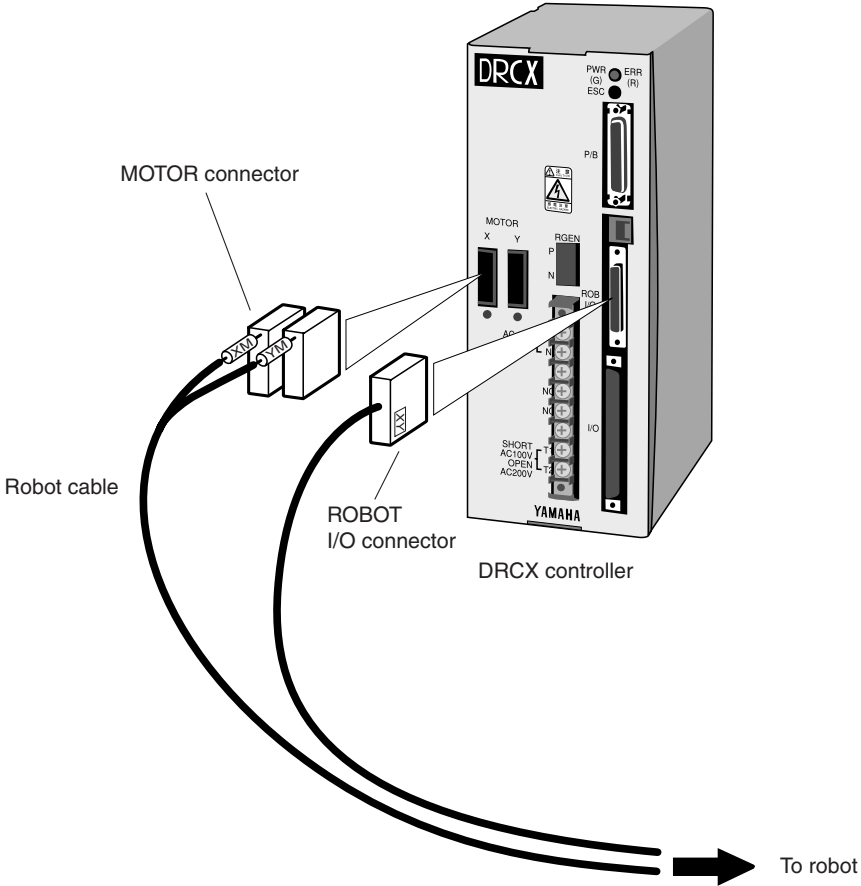


Fig. 3-1 Connection to DRCX controller

7-2 Connecting with the TRCX controller

7-2-1 3-axis model

⚠ WARNING

When connecting the robot cable, insert the robot cable connector straight into the mating connector on the controller. Inserting the connector while tilted might cause the pins to make poor contact, causing robot malfunction and the connector itself might even break.

⚠ CAUTION

These connectors all work in only one direction. Take a good look at the connector shape before trying to attach it. Connecting the wrong way may damage the connectors.

⚠ CAUTION

With the TRCX3 controller, the MOTOR connectors XM and ZM have the same shape. Take care not to reverse the robot cable XM and ZM when connecting.

- 1) Prepare the required tools.
Precision phillips-head screwdriver.
- 2) While referring to Table 3-2 and Fig.3-2, securely insert the motor connector into the correct position on the controller until a click is heard.
- 3) While referring to Table 3-2 and Fig.3-2, insert the robot I/O cable into the correct position on the controller.
- 4) Use the precision phillips-head screwdriver to tighten the robot I/O connector screws.

Table 3-2

| Robot cable | TRCX | |
|-------------|---------|----------------|
| XM | MOTOR X | Main side unit |
| YM | MOTOR Y | |
| XY | ROB I/O | |
| ZM | MOTOR Z | Sub-side unit |
| Z | ROB I/O | |

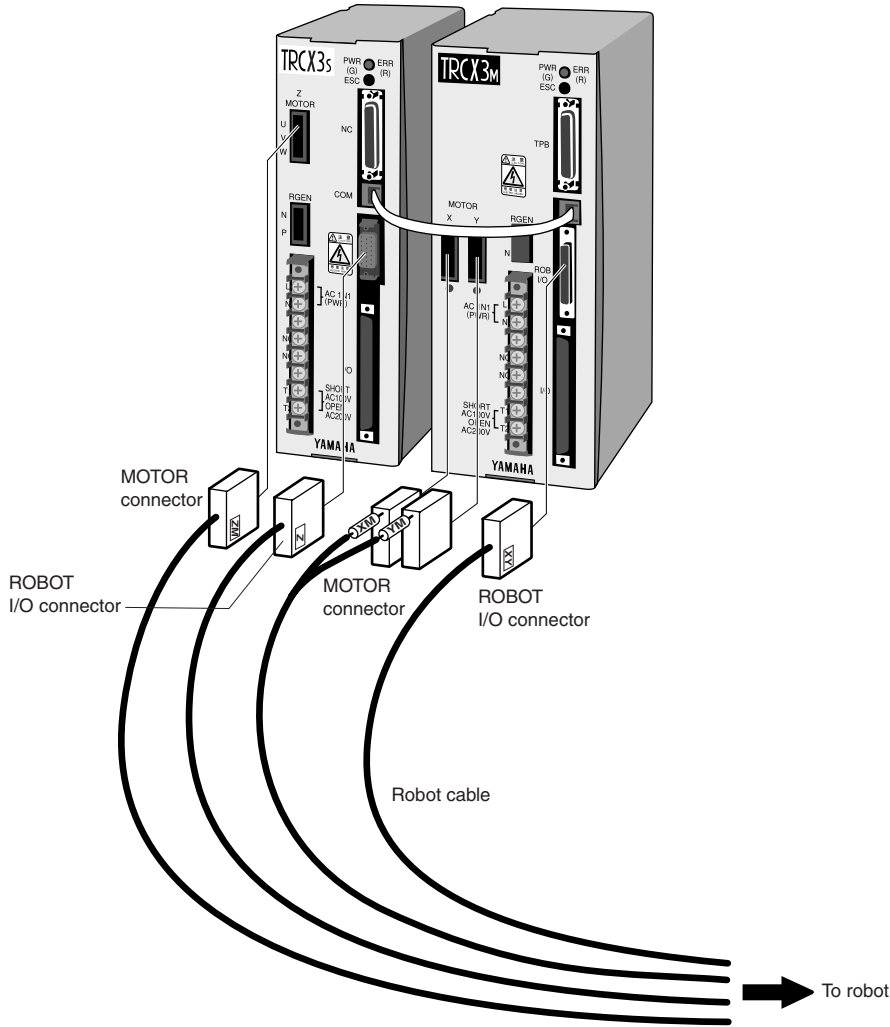


Fig. 3-2 Connection to TRCX controller (3-axis model)

7-2-2 4-axis model

⚠ WARNING

When connecting the robot cable, insert the robot cable connector straight into the mating connector on the controller. Inserting the connector while tilted might cause the pins to make poor contact, causing robot malfunction and the connector itself might even break.

⚠ CAUTION

These connectors all work in only one direction. Take a good look at the connector shape before trying to attach it. Connecting the wrong way may damage the connectors.

⚠ CAUTION

With the TRCX4 controller, the MOTOR connector and PI connector shapes are the same for the XY-axis and ZR-axis. Take care not to reverse the robot cables XY and ZR when connecting.

- 1) Prepare the required tools.
Precision phillips-head screwdriver.
- 2) While referring to Table 3-3 and Fig.3-3, securely insert the motor connector into the correct position on the controller until a click is heard.
- 3) While referring to Table 3-3 and Fig.3-3, insert the robot I/O cable into the correct position on the controller.
- 4) Use the precision phillips-head screwdriver to tighten the robot I/O connector screws.

Table 3-3

| Robot cable | TRCX | |
|-------------|---------|----------------|
| XM | MOTOR X | Main side unit |
| YM | MOTOR Y | |
| XY | ROB I/O | |
| ZM | MOTOR X | Sub-side unit |
| RM | MOTOR Y | |
| ZR | ROB I/O | |

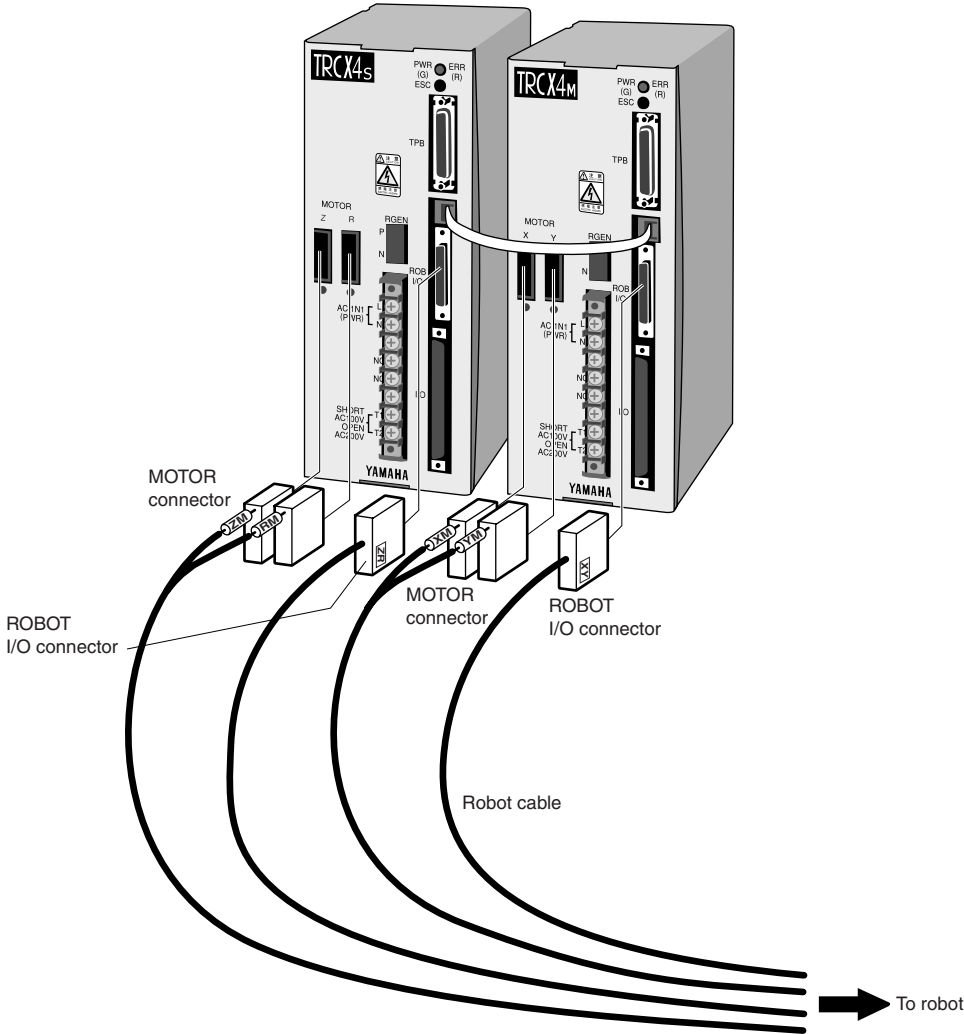


Fig. 3-3 Connection to TRCX controller (4-axis model)

7-3 Connecting to the QRCX or RCX40 controller

⚠ WARNING

When connecting the robot cable, insert the robot cable connector straight into the mating connector on the controller. Inserting the connector while tilted might cause the pins to make poor contact, causing robot malfunction and the connector itself might even break.

⚠ CAUTION

These connectors all work in only one direction. Take a good look at the connector shape before trying to attach it. Connecting the wrong way may damage the connectors.

⚠ CAUTION

With the RCX40, QRCX controller, the MOTOR connector and PI connector shapes are the same for the XY-axis and ZR-axis. Take care not to reverse the robot cables XY and ZR when connecting.

- 1) Prepare the required tools.
Precision phillips-head screwdriver.
- 2) While referring to Table 3-4 and Fig.3-4, Fig.3-5, securely insert the motor connector into the correct position on the controller until a click is heard.
- 3) While referring to Table 3-4 and Fig.3-4, Fig.3-5, insert the robot I/O cable into the correct position on the controller.
- 4) Use the precision phillips-head screwdriver to tighten the robot I/O connector screws.

Table 3-4

| Robot cable | RCX40, QRCX |
|-------------|-----------------|
| XM | MOTOR1 (X side) |
| YM | MOTOR1 (Y side) |
| ZM | MOTOR2 (Z side) |
| RM | MOTOR2 (R side) |
| XY | PI1 |
| ZR | PI2 |

Note) This is for the main robot.

Refer to the controller instruction manual for details.

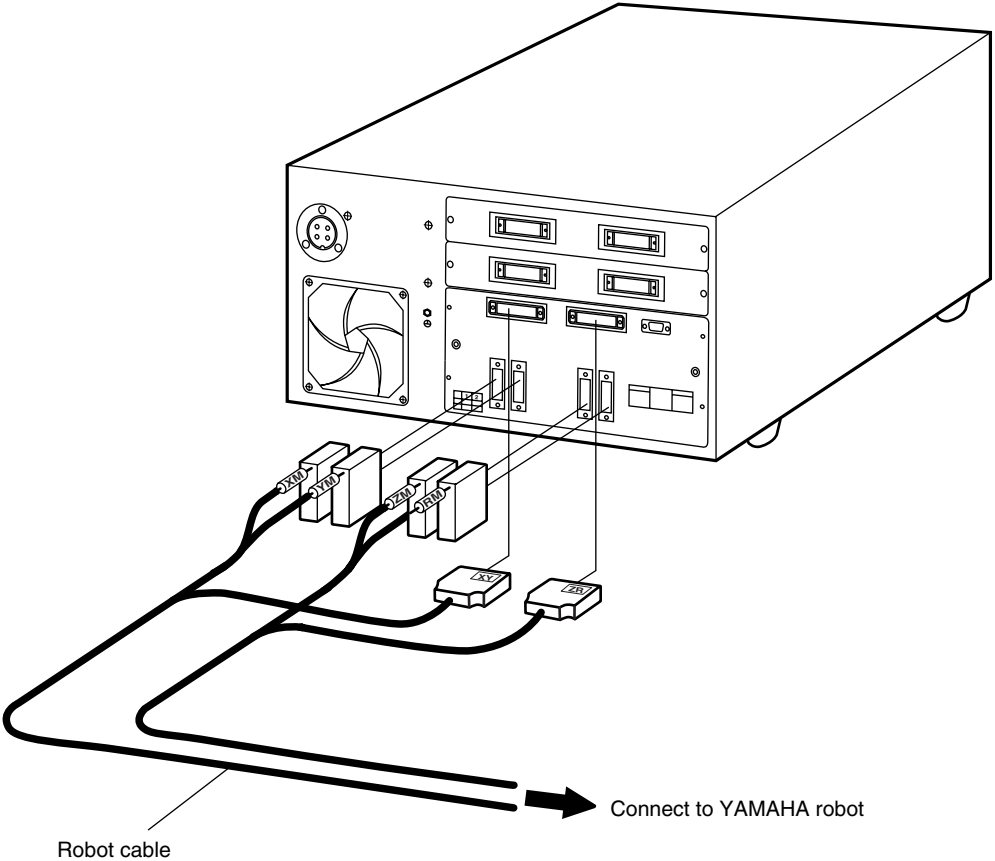


Fig. 3-4 Connection to QRCX controller

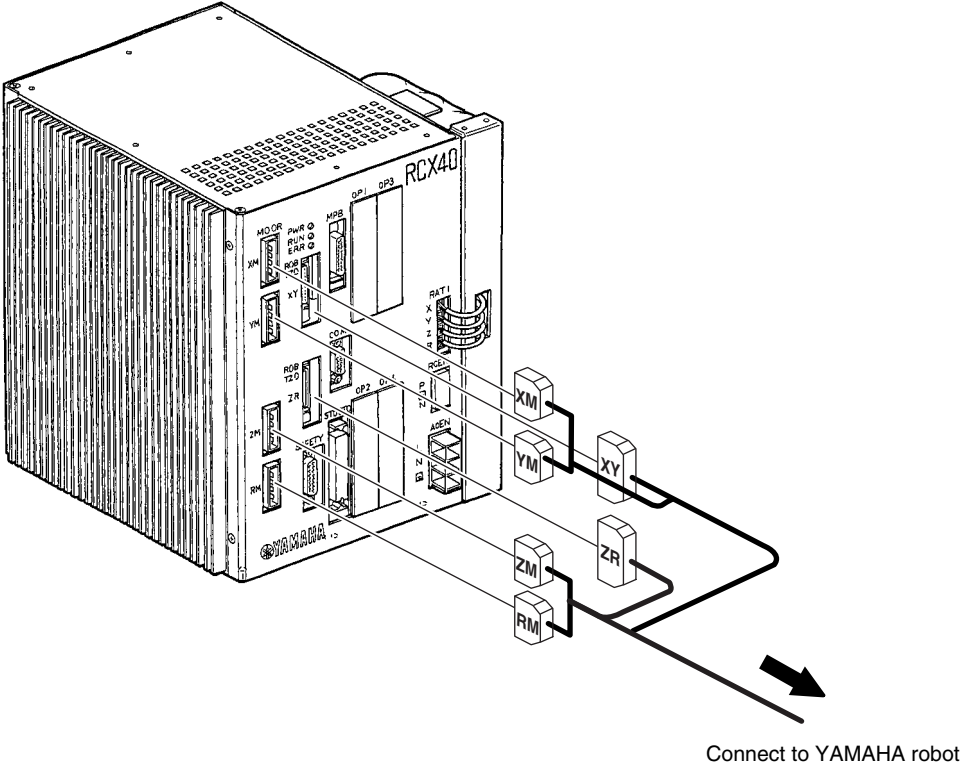


Fig. 3-5 Connection to RCX40 controller

8 Installing the Tool

WARNING

The user must responsibly determine the bolt type and tightening torque for the tool installation, and must accurately tighten these. Improper installation could cause the tool to dislocate during operation and lead to serious accidents.

CAUTION

Install the tool at the designated section. Avoid installing heavy objects on the other sections (Y-axis frame or X-axis slider, etc.). Failure to observe this could lead to vibration during operation (especially during positioning).

Install user's tools on the sections designated as tool installation sections, such as the robot slider and bracket. (Refer to Chapter 2. Names of each part and explanations for each robot in Chapter 6 and following for each robot for details on the designated sections.)

Refer to the explanation for each robot in Chapter 6 and following for details on the actual installation methods.

9 User Wiring and User Piping

⚠ CAUTION

Do not clamp the wires or pipes to the outside of the whipover cable. The whipover cable could sag or break and ultimately be disconnected.

After completing all work up to step 8, wires and pipes are laid from the user's devices or robot controller to the tools and valves installed on the robot.

■ Cable carrier type

Carry out wiring and piping using the attached cable carrier.

Refer to the explanation for each robot in Chapter 6 and following for details on the actual wiring and piping methods and precautions.

The cable carrier contains a user I/O cable (0.3sq×10) for user wiring, so there is no need to add harnesses and route them through the cable carrier.

Refer to Chapter 3, “12. Specifications” for the specifications on the user I/O wire, and the explanation of each robot in Chapter 6 for details on the wiring methods.

■ whipover cable carrier type

The signal wires (0.3mm²×10 wires) and air tubes (4×2.5×2 tubes) are laid in the whipover cable beforehand. Use these for wiring and piping to the tools.

Refer to the explanation for each robot in Chapter 6 and following for details on the actual wiring and piping methods and precautions.

10 Setting the Robot

10-1 Setting the payload

⚠ CAUTION

Always input an accurate value as an incorrect value can lead to various trouble including vibration and a drop in machine life.

⚠ CAUTION

When installing a weight other than the tool or workpiece on the robot's moving section, add that weight. (For example, if an air valve is fixed on the Y-axis frame, include that weight in the payload.)

The optimum acceleration and servo gain, etc., are automatically set for the cartesian robot XY-X Series by inputting the controller payload parameters. Set the total value of the tool weight and workpiece weight as a kg unit in the payload parameter.

■ List of payload parameters

| | |
|-------------|---------------------------------|
| Controller | Payload parameter |
| DRCX | PRM90 |
| TRCX3 | PRM130 |
| TRCX4 | PRM170 |
| RCX40, QRCX | Robot parameter "1. Tip weight" |

Refer to the following sections in the Robot Controller Instruction Manual, and set the payload parameters.

For DRCX or TRCX controller

Chapter 5 Parameters

For RCX40 or QRCX controller

Chapter 4 Operation > 12. System Mode > 12-1-1. Robot parameters

10-2 Setting the maximum speed

When operating a ball screw driven robot, the ball screw's free length will increase as the movement stroke increases, and the resonance frequency will drop. Thus, the ball screw may resonate and generate vigorous vibration depending on the motor rotation speed. (The speed at which resonance occurs is called the whirling speed.) To prevent this resonance, the maximum speed setting must be lowered if the movement stroke increases depending on the robot model.

⚠ CAUTION

Continuing use while the ball screw is resonating will cause the ball screw to wear out prematurely.

⚠ CAUTION

There are cases when the whirling speed is not reached depending on the movement point. (The ball screw's nut acts as the support material, so when operating the robot near the center of the stroke, the ball screw's free length will be shortened and resonance will not occur as easily.) If resonance does not occur when the robot is actually operated, the speed can be increased.

■ Models requiring lower maximum speed setting

| | |
|------|-----------------------------|
| FXYY | X-axis stroke 750mm or more |
| SXYX | X-axis stroke 750mm or more |
| MXYY | X-axis stroke 850mm or more |
| HXYX | X-axis stroke 850mm or more |

Refer to the catalog for the maximum speed setting values.

The maximum speed can be reduced by lowering the speed setting for automatic operation or by lowering the speed with a program command. The user should select the suitable method.

Refer to the following sections in the Robot Controller Instruction Manual for details on changing the speed setting during automatic operation.

For ERCX, SRCX, DRCX or TRCX controller

Chapter 9 Robot Operation > 9-3. Automatic Operation

For RCX40 or QRCX controller

Chapter 4 Operation > 9. "Auto" Mode > 9-6. Changing the automatic movement speed

10-3 Setting the acceleration

The acceleration is automatically set for the Cartesian robot XY-X Series when the payload parameter is set, so large vibration will not occur during operation. However, if the tool or workpiece is greatly offset from the robot, vibration may occur especially during positioning.

In this case, lower the controller's acceleration setting.

Lowering the acceleration is also effective if tool or workpiece vibration occurs due to a low tool rigidity.

■ List of acceleration parameters

| Controller | Acceleration parameter |
|-------------|--|
| DRCX | X-axis PRM51 Y-axis PRM91 |
| TRCX3 | X-axis PRM51 Y-axis PRM91 Z-axis PRM131 |
| TRCX4 | X-axis PRM51 Y-axis PRM91 Z-axis PRM131 R-axis PRM171 |
| RCX40, QRCX | Axis parameter "1. Acceleration coefficient" |

Refer to the following sections in the Robot Controller Instruction Manual, and change the acceleration.

For DRCX or TRCX controller

Chapter 5 Parameters

For RCX40 or QRCX controller

Chapter 4 Operation > 12. "System" Mode > 12-1-2. Axis parameters

11 Absolute Reset

Refer to this section and set the origin position before using the robot.

The Cartesian robot XY-X Series uses an absolute method position detector, and thus return-to-origin is not required when the controller power is turned ON again. However, the origin position must be set the first time the controller power is turned ON from any of the following states.

- (1) When robot cable is connected for the first time after delivery
- (2) When the cable connection between the robot cable and controller has been disconnected
- (3) When the absolute battery is not connected
- (4) When the motor or cable is replaced

One of the following errors will appear when the power is turned ON in any of the above cases, but this is not an error. The robot will operate normally when the power is turned ON again.

For DRCX or TRCX controller

- 15: FEEDBACK ERROR 2
- 23: ABS. BAT. L-VOLTAGE
- 24: ABS. DATA. ERROR

For QRCX controller

- 17.80:D?.ABS.Encoder backup error
- 17.81:D?.ABS.Encoder battery alarm
- 17.85:D?.ABS.Encoder system error
- 17.92:D?.ABS.Cable disconnected
- 17.93:D?.ABS.Data overflow
- 17.94:D?.ABS.Battery degradation

For RCX40 controller

- 17.27 : D?.ABS. backup failed (CPU)
- 17.80 : D?.ABS. backup failed (DRIVER)
- 17.81 : D?.ABS.battery wire breakage
- 17.92 : D?.Resolver disconnected during power off
- 17.93 : D?.Position backup counter overflow
- 17.94 : D?.ABS.battery low voltage
- etc

Note) Question marks (?) in the above error messages indicate the axis numbers.

■ Setting the origin position

[1] For robot configured of only linear movement axis

The above type of robot uses a stroke end detection method as origin return. The motor side stroke end is set as the origin detection position before shipment from the factory. (Excluding ZH and the Z-axis of ZS, ZRS.)

⚠ CAUTION

Avoid changing the origin position to the non-motor side as the position could deviate, trouble could occur, and could be hazardous in some cases. Always consult with YAMAHA when the origin position must be changed.

Refer to the following sections in the Robot Controller Instruction Manual and set the origin.

For ERCX, SRCX, DRCX or TRCX controller

Chapter 9 > 9-1. Returning-to-the Origin > 9-1-1. Return-to-origin by the search method

For QRCX controller

Chapter 11 > 11-9. Absolute reset

For RCX40 controller

Chapter 11 > 11-8. Absolute reset

[2] When robot contains a rotary axis

Target rotary axis

| | |
|-------|------------------------------|
| RF | (R-axis for SXYX/MXYX/SXYBX) |
| RL/RH | (R-axis for HXYX) |
| RS | (R-axis for ZRS unit) |

The above rotary axes uses mark method return-to-origin.

Thus, if the robot contains this type of axis, the origin position of the rotary axis can be set freely by the user.

Refer to the following sections in the Robot Controller Instruction Manual, move the robot to the preferred origin, and then set the origin.

For DRCX or TRCX controller

Chapter 9 > 9-1. Returning-to-the Origin > 9-1-2. Return-to-origin by the mark method

Return the rotary axis to the origin before returning the other linear movement axes to the origin. (Refer to section [1] above for details on returning the linear movement axis to the origin.)

For QRCX controller

Chapter 11 > 11-9. Absolute reset

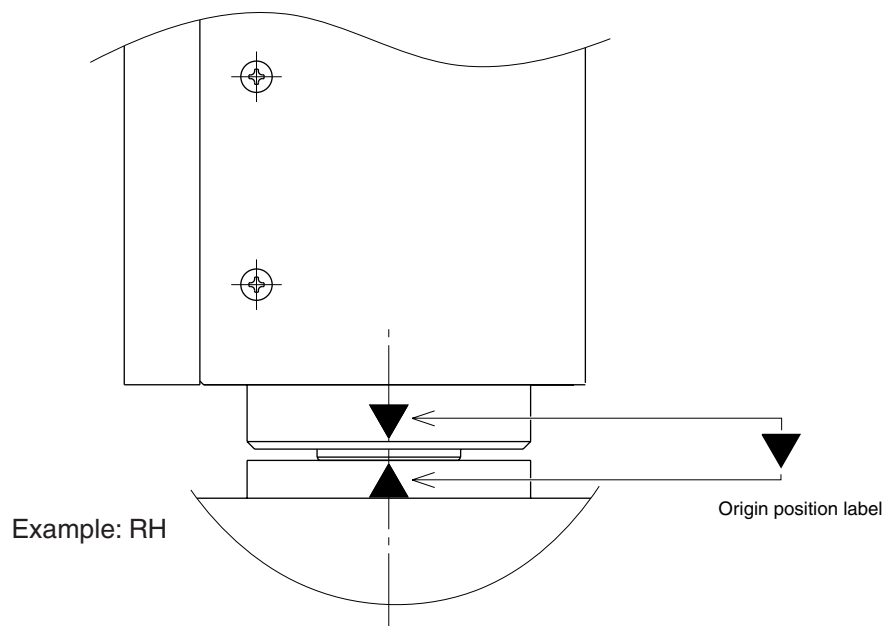
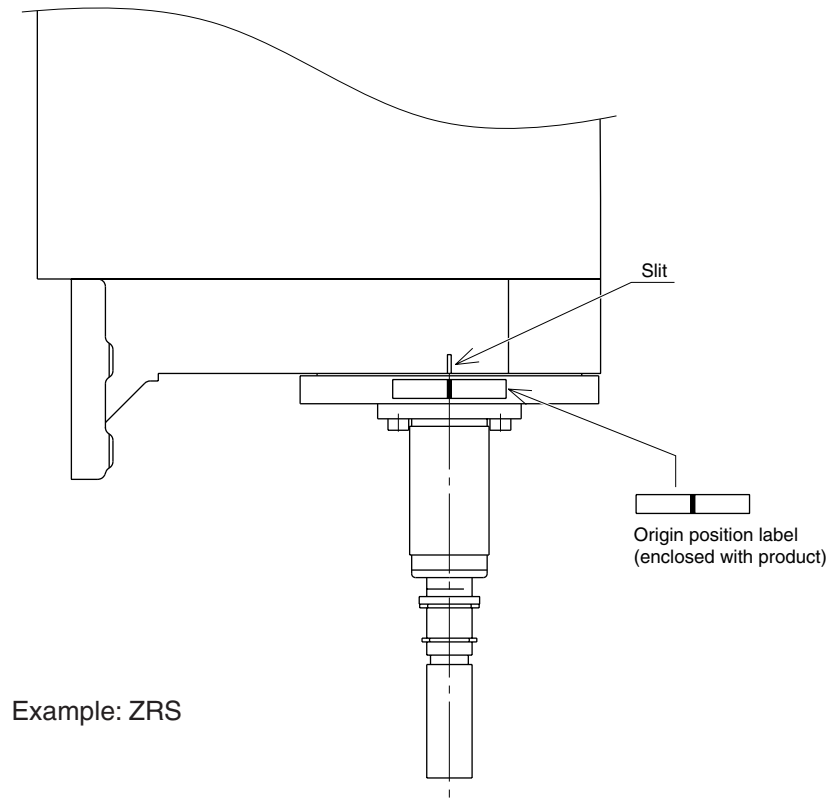
For RCX40 controller

Chapter 11 > 11-8. Absolute reset

When MANUAL > RST.ABS > ALL is selected on the MPB screen (see “11-9-3” in QRCX owner’s manual or “11-8-3” in RCX40 owner’s manual), first perform absolute reset for the rotating axis and then other linearmovement axes. When performing absolute reset for each axis one by one (see “11-9-2” in QRCX owner’s manual or “11-8-2” in RCX40 owner’s manual), you can begin in any order.

After setting the origin position, attach the label enclosed with the robot so that it acts as a match mark on the tool side and Robot side. This match mark will be the reference for subsequent origin settings.

Figure



CHAPTER 4

Periodic Inspections

| | | |
|-----|---|-----|
| 1 | Outline | 4-1 |
| 2 | Precautions | 4-1 |
| 3 | Daily inspection | 4-2 |
| 4 | Three-month inspection | 4-2 |
| 5 | Six-month inspection | 4-3 |
| 6 | Three-year inspection | 4-4 |
| 7 | Replenishing the grease | 4-5 |
| 8 | Maintenance and inspection of harmonic drives | 4-6 |
| 8-1 | Harmonic grease replacement period | 4-7 |

MEMO

1 Outline

Implementation of periodic inspections is essential to ensure safe and efficient operation of the YAMAHA robot.

The periodic inspection items and procedures for the XY Series are described in this chapter.

The periodic inspections include;

- Daily inspection
- Three-month inspection
- Six-month inspection
- Three-year inspection

Thoroughly understand the details of the inspection and observe the precautions during this work.

2 Precautions

Always read the safety precautions in “Chapter 1 Using the Robot Safely” and follow the instructions. Important precautions are listed below again for reference.

DANGER

- **Never enter the robot’s movement area when operating the robot during adjustments and inspections. Pay attention to the robot movements and surrounding safety so that the emergency stop button can be pressed immediately when any hazard is sensed.**
-

WARNING

- **Always turn the controller power switch and external power distribution board switch OFF before starting adjustments and inspections that do not require robot operation.**
 - **Press the emergency stop button when robot operation is not required during the electrical system inspection.**
 - **Use only lubricant designated by YAMAHA or your dealer.**
 - **Use only parts designated by YAMAHA or your dealer when replacing parts. Make sure that foreign matter does not enter the robot during adjustment, part replacement or reassembly.**
 - **Never modify the robot or controller, etc. Modifications may result in improper specifications and may threaten operator safety.**
 - **Always tighten the bolts and screws securely after completing adjustments or inspections.**
 - **During robot adjustment or inspection, place a sign indicating that the robot is being adjusted or inspected, to prevent others from touching the switches. Provide a switch key lock mechanism or assign a monitor if necessary.**
-

3 Daily inspection

Check the following points before and after robot operation every day. Make adjustments and replacements as necessary.

| Check point | Check items |
|-----------------------------|---|
| Safeguard enclosure | Check that the safeguard enclosure is securely fixed at the designated position. |
| Cables | Check for damages, dents and excessive bending. Check for the adherence of chemicals. |
| Motor, speed reduction gear | Check for abnormal vibration or noise, and for abnormal temperature rise. |
| Pneumatic devices | <ul style="list-style-type: none"> • Check that the air pressure is correct. • Check that there are no air leaks. • Check that the water has been drained. • Check that the air filter is not contaminated. |

4 Three-month inspection

Check the following points every three months, and replenishing grease if required. (To replace grease, see “7 Replenishing the grease”.)

| Check point | Check items |
|---|---|
| Replenishment of grease to X, Y and Z axis ball screw, linear guide and ball spline | <ul style="list-style-type: none"> • Clean off any dirt or contamination. Replenish the grease after cleaning. • Replenish grease if the items on the left are dry or do not have enough grease. <p>Standard specifications: Alvania No. 2 (Showa Shell) Daphne Eponex No. 2 (Idemitsu) Clean room specifications: LG-2 (NSK)</p> |

CAUTION

Use of grease not recommended by YAMAHA may lead to a drop in the ball screw, linear guide, ball spline and linear bushing shaft life. When using the clean room specifications, the degree of cleanliness may drop.

5 Six-month inspection

Check the following points every six months, and make adjustments or replacements as required.

| Check point | Check items |
|---|--|
| Robot's main bolts and screws | Check for looseness, and tighten if necessary. |
| X-axis, Y-axis and Z-axis drive sections (ball screw, linear guide) | <ul style="list-style-type: none"> • Check for looseness in the X-axis, Y-axis and Z-axis drive section (ball screw, linear guide). Tighten if necessary. • Check for vibration during operation. Tighten the drive section, and X-axis, Y-axis and Z-axis installation bolts if necessary. • Check for looseness caused by wear. Contact YAMAHA if any abnormality is found. |
| Z-axis ball spline and ball screw (for ZS, ZRS) | Check for looseness. (Contact YAMAHA if any abnormality is found.) |
| R-axis timing belt (for ZRS) | <ul style="list-style-type: none"> • Check the timing belt tension. • Check the timing belt for abnormalities (cracks or cuts). |
| Wiring in robot | <ul style="list-style-type: none"> • Check the cables for damage. • Check the relay connectors, etc., for looseness. |
| Belt (for FXYBX, SXYBX, ZRS, HXYLX) | <ul style="list-style-type: none"> • Inspect the timing belt for abnormalities (cracks or cuts). • Check the timing belt tension. |
| Controller | <ul style="list-style-type: none"> • Check the terminals for looseness. • Check the connection connectors for looseness. |
| Controller rear panel cooling fan | <ul style="list-style-type: none"> • Check that the fan is rotating. • Check whether anything is obstructing the fan. • Check the rotating fan for abnormal sounds. Check visually if any abnormal sound is heard, and remove any foreign matter. Contact YAMAHA if no foreign matter is found. • Check the fan cover for contamination. Remove and clean the cover if contaminated. |

6 Three-year inspection

Check the following points once every three years, and adjust or replenish grease as necessary.

If the robot is used frequently, inspect the robot at an earlier stage.

| Check point | Check items |
|--|--|
| R-axis speed reduction gear | Disassemble and check the harmonic drive. Replace the grease.* |
| X-axis, Y-axis and Z-axis drive section (Ball screw nut section, motor section and linear guide) | Check the ball screws, nuts and linear guide for looseness caused by wear. |

*To replace harmonic drive grease, see "8 Maintenance and inspection".

7 Replenishing the grease

⚠ WARNING

Precautions for handling grease

- Inflammation may occur if the grease gets into eyes.
Always wear protective goggles, etc., to protect eyes when handling the grease.
- Inflammation may occur if the grease gets on skin. Wear protective gloves, etc., to protect skin when handling the grease.
- Do not consume the grease. (Consumption of grease will cause diarrhea and vomiting.)
- Wear protective gloves when opening the can to prevent injury to hands.
- Store the grease out of the reach of children.
- Do not heat the grease or place it near fire. There is a risk of igniting or fires.

Remedial measures

- If the grease gets into eyes, flush eyes for 15 minutes with clean water, and then see doctor.
- If the grease gets on skin, wash off completely with water and soap.
- If the grease is consumed, do not induce vomiting, and instead consult with a doctor immediately.

⚠ CAUTION

Use of grease not recommended by YAMAHA may lead to a drop in the ball screw, linear guide, ball spline and linear bushing shaft life. When using the clean room specifications, the degree of cleanliness may drop.

⚠ CAUTION

When replenishing clean grease, manually apply a thin coat on the screws and the entire length of the spline shaft.

Refer to the periodic inspections in the explanation for each robot in Chapter 6 and following, and replenish the grease. Observe the following points when replenishing the grease.

8 Maintenance and inspection of harmonic drives

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts during inspection or servicing, turn OFF the controller, wait for a while and check that the part has cooled.

⚠ WARNING

Precautions for handling harmonic grease and washing oil

- Inflammation may occur if the grease gets into eyes.
Always wear protective goggles, etc., to protect eyes when handling the grease.
- Inflammation may occur if the grease gets on skin. Wear protective gloves, etc., to protect skin when handling the grease.
- Do not consume the grease. (Consumption of grease will cause diarrhea and vomiting.)
- Wear protective gloves when opening the can to prevent injury to hands.
- Store the grease out of the reach of children.
- Do not heat the grease or place it near fire. There is a risk of igniting or fires.

Remedial measures

- If the grease gets into eyes, flush eyes for 15 minutes with clean water, and then see doctor.
 - If the grease gets on skin, wash off completely with water and soap.
 - If the grease is consumed, do not induce vomiting, and instead consult with a doctor immediately.
-

⚠ WARNING

Disposal of harmonic grease, spent washing oil and waste containers

- Disposal methods are specified by law. Always follow local laws when disposing of these items.
 - Do not apply pressure on an empty container. The container could rupture if pressurized.
 - Do not weld, heat, open a hole or cut this container. Failure to observe this could lead to an explosion and igniting of the residual matter.
-

⚠ CAUTION

Use of grease not recommended by YAMAHA could lead to a drop in the harmonic drive life.

⚠ CAUTION

Harmonic drive

- Do not apply strong impacts on any part with a hammer, etc. Do not damage or mark the parts by dropping. There is a risk of damage.
- The specified performance cannot be attained if a damaged part is used. Continued use of a damaged part could lead to trouble such as rupture.

Harmonic grease HC-1A (Harmonic Drive Systems) is used to lubricate the harmonic drive used for the R-axis (ZRL, ZRH, ZRF unit) speed reduction gear. The life of the harmonic drive could be shortened if this grease deteriorates.

Determine an inspection interval at every three years or to suit the usage conditions, and replace the grease.

The ZRS unit's R-axis also uses a harmonic drive, but the grease does not need to be replaced.

8-1 Harmonic grease replacement period

The harmonic grease should be replaced when the total number of wave generator rotations reaches 1.5×10^8 times (at -10°C to $+40^\circ\text{C}$). Thus, the replacement period will differ according to the following usage conditions.

- n : Number of arm movements in one minute
- θ : Average arm rotation in one movement
- N : 1/deceleration rate
- h : Number of operation hours per day
- D : Number of operation days per year

The method of calculating the replacement period using the following conditions is shown as an example.

- n : 10 times
- θ : 1/4 rotation
- N : 80
- h : 24 hours/day
- D : 240 days/year

$$\begin{aligned} \text{Replacement period} &= 1.5 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta) \\ &= 1.5 \times 10^8 / (10 \times 60 \times 24 \times 240 \times 80 \times 1/4) = 2.17 \text{ years} \end{aligned}$$

MEMO

CHAPTER 5



Specifications

| | | |
|-----|----------------------|-----|
| 1 | Specifications | 5-1 |
| 1-1 | Robot cable | 5-1 |
| 1-2 | User I/O cable | 5-5 |

MEMO

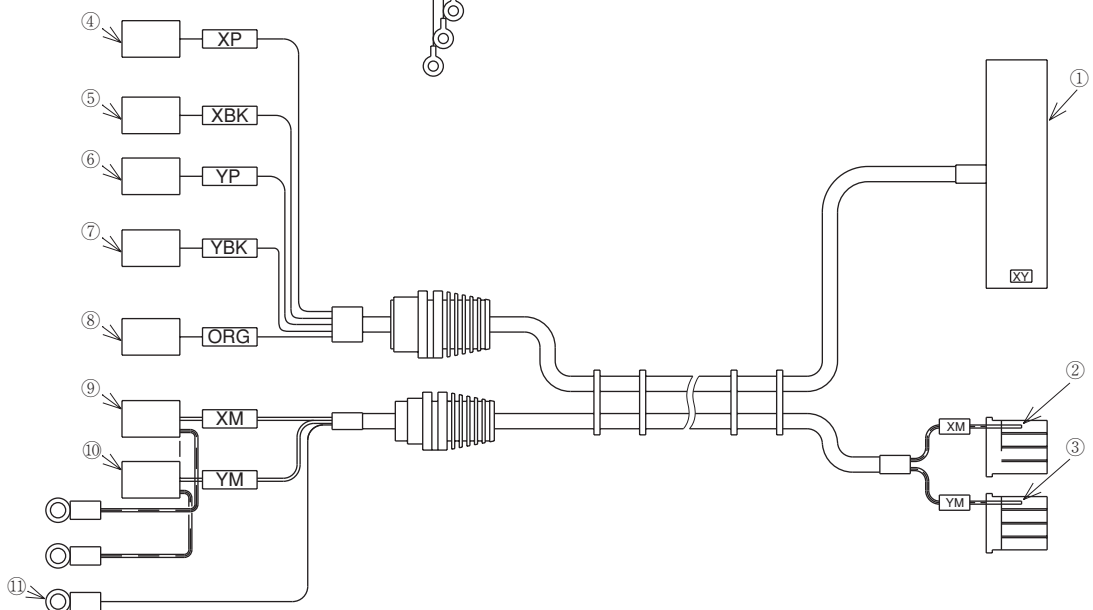
1 Specifications

The specifications of each robot's common parts are shown below.

1-1 Robot cable

This cable is used to connect the controller and robot.

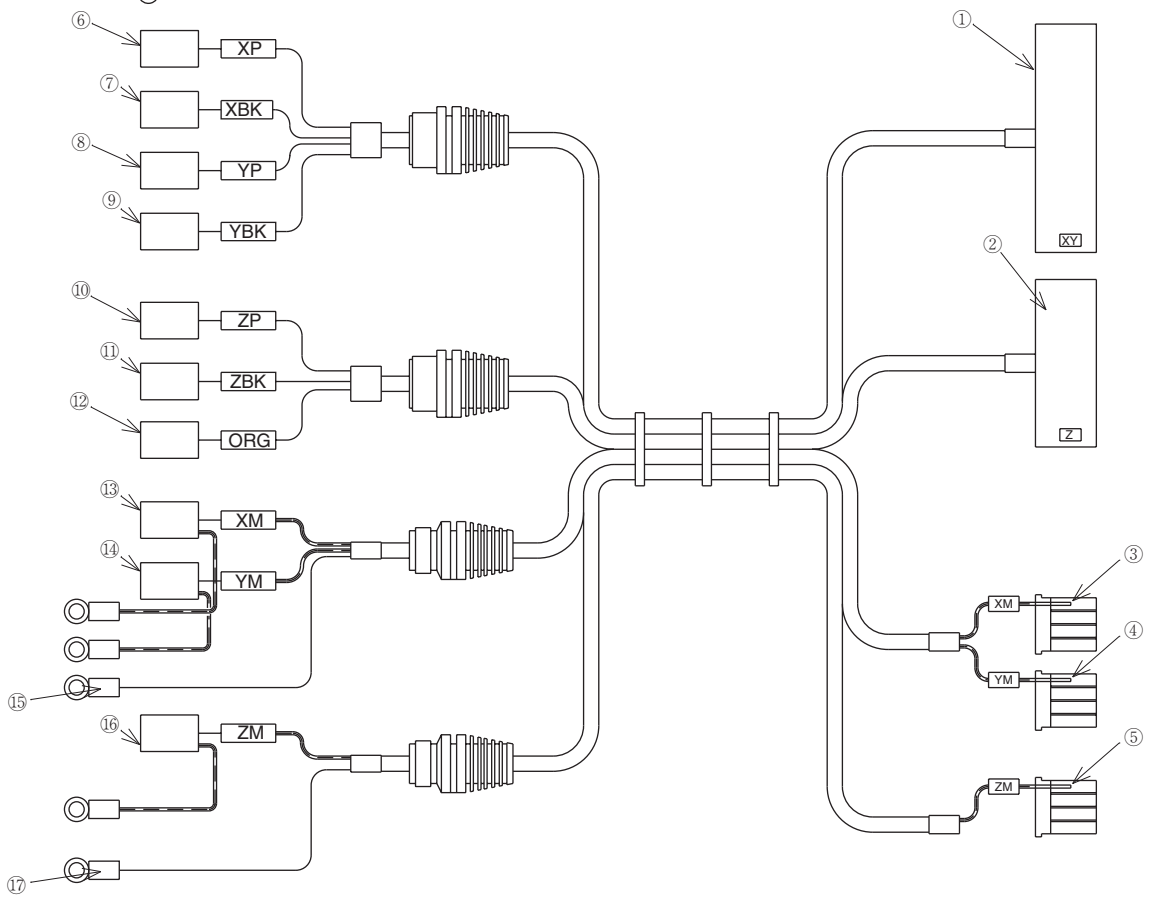
| Signal | Connector | No | Connection | No | Connector | Color/No. | Wire |
|----------|--|----------|------------|----|--------------|---------------|--------------|
| Resolver | S2 S4 S1 S3 R1 R2 DG | XP ④ | 1 | 1 | XY ① | Blue | 0.3sq |
| | | | 2 | 2 | | Orange | twisted pair |
| | | | 3 | 3 | | Green | 0.3sq |
| | | | 4 | 4 | | Brown | twisted pair |
| | | | 5 | 5 | | Gray | 0.3sq |
| | | | 6 | 6 | | Red | twisted pair |
| | | | 7 | 7 | | Green | 0.3sq |
| Brake | MB+ MB- | XBK ⑤ | 1 | 14 | | Black | 0.3sq |
| | | | 2 | 16 | | Yellow | twisted pair |
| Resolver | S2 S4 S1 S3 R1 R2 DG | YP ⑥ | 1 | 19 | | Pink | 0.3sq |
| | | | 2 | 20 | | Purple | twisted pair |
| | | | 3 | 21 | | White | 0.3sq |
| | | | 4 | 22 | | Blue/Red | twisted pair |
| | | | 5 | 23 | | Orange/White | 0.3sq |
| | | | 6 | 24 | Green/White | twisted pair | |
| | | | 7 | 25 | Green | 0.3sq | |
| Brake | MB+ MB- | YBK ⑦ | 1 | 32 | Brown/White | 0.3sq | |
| | | | 2 | 34 | Gray/White | twisted pair | |
| HLIM | | | | 10 | Green | | |
| GND24 | | | | 11 | | | |
| HLIM | | | | 28 | Green | | |
| GND24 | | | | 29 | | | |
| Sensor | 24V ORG GND24 | ORG ⑧ | 1 | 27 | Red/White | 0.3sq | |
| | | | 2 | 30 | Yellow/Black | 0.3sq | |
| | | | 3 | 31 | Pink/Black | twisted pair | |
| U | | | | 1 | | 0.75sq | |
| V | | | | 2 | | 0.75sq | |
| W | | | | 3 | | 0.75sq | |
| FG | Ring-tongue terminal | ⑩ | | 4 | | Yellow /Green | 0.75sq |
| U | | | | 1 | XM ② | | |
| V | | | | 2 | | | |
| W | | | | 3 | | | |
| FG | Ring-tongue terminal | ⑪ | | 4 | | | |
| | | | | 1 | YM ③ | | |
| | | | | 2 | | | |
| | | | | 3 | | | |
| | | | | 4 | | | |



2-axis robot cable

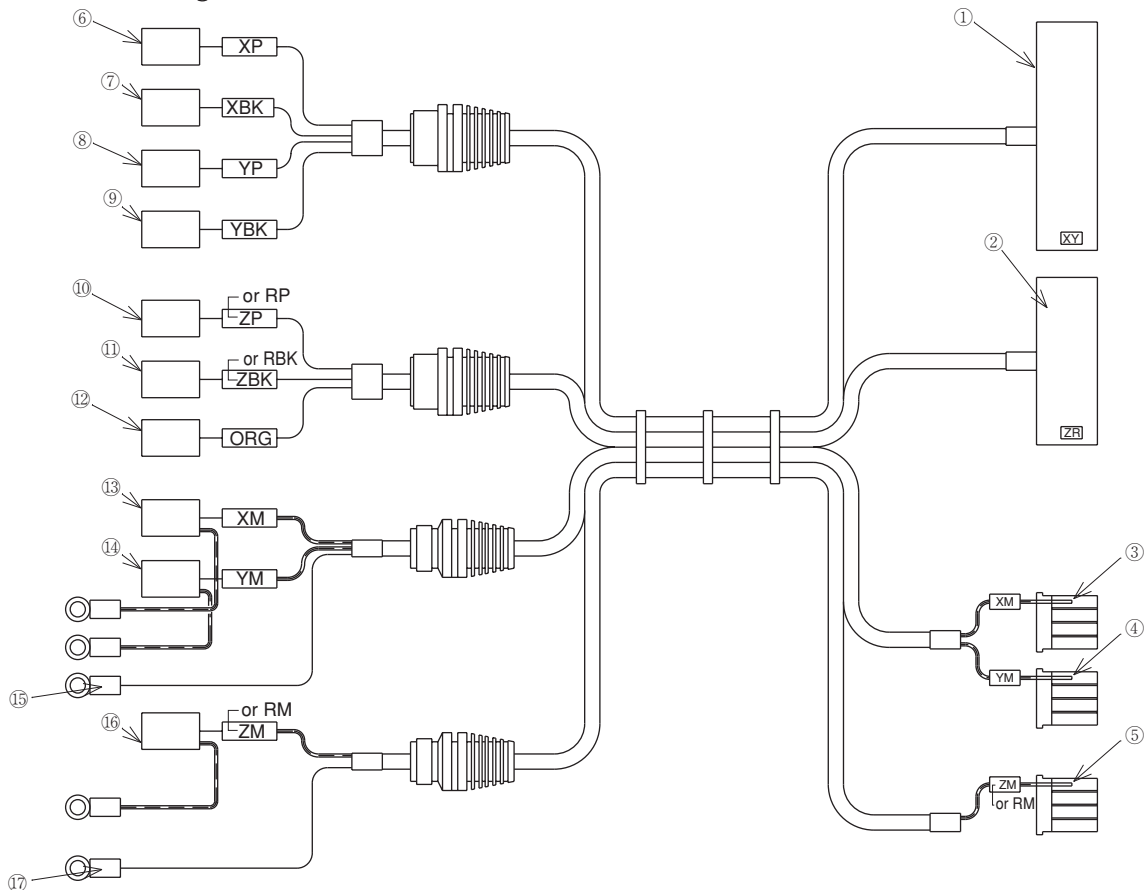
Chapter 5 Specifications

| Signal | Connector | No | Connection | No | Connector | Color/No. | Wire | Signal | Connector | No | Connection | No | Connector | Color/No. | Wire | |
|-------------|------------------------|----|------------|----|-----------|--------------|--------------|-------------|------------------------|----|------------|--------|-----------|--------------|--------------|--|
| Resolver S2 | XP ⑥ | 1 | | 1 | XY ① | Blue | 0.3sq | Resolver S2 | ZP ⑩ | 1 | | 1 | Z ② | Blue | 0.3sq | |
| S4 | | 2 | | 2 | | Orange | twisted pair | S4 | | 2 | | Orange | | twisted pair | | |
| S1 | | 3 | | 3 | | Green | 0.3sq | S1 | | 3 | | Green | | 0.3sq | | |
| S3 | | 4 | | 4 | | Brown | twisted pair | S3 | | 4 | | Brown | | twisted pair | | |
| R1 | | 5 | | 5 | | Gray | 0.3sq | R1 | | 5 | | Gray | | 0.3sq | | |
| R2 | | 6 | | 6 | | Red | twisted pair | R2 | | 6 | | Red | | twisted pair | | |
| DG | | 7 | | 7 | | Green | 0.3sq | DG | | 7 | | Green | | 0.3sq | | |
| Brake MB+ | XBK ⑦ | 1 | | 14 | XY ① | Black | 0.3sq | Brake MB+ | ZBK ⑪ | 1 | | 17 | Z ② | Black | 0.3sq | |
| MB- | | 2 | | 16 | | Yellow | twisted pair | MB- | | 2 | | 18 | | Yellow | twisted pair | |
| Resolver S2 | YP ⑧ | 1 | | 19 | XY ① | Pink | 0.3sq | Sensor 24V | ORG ⑫ | 1 | | 13 | Z ② | Pink | 0.3sq | |
| S4 | | 2 | | 20 | | Purple | twisted pair | ORG | | 2 | | 12 | | White | 0.3sq | |
| S1 | | 3 | | 21 | | White | 0.3sq | GND24 | | 3 | | 15 | | Blue/Red | twisted pair | |
| S3 | | 4 | | 22 | | Blue/Red | twisted pair | | | | | | | | | |
| R1 | | 5 | | 23 | | Orange/White | 0.3sq | | | | | | | | | |
| R2 | | 6 | | 24 | | Green/White | twisted pair | | | | | | | | | |
| DG | | 7 | | 25 | | Green | 0.3sq | | | | | | | | | |
| Brake MB+ | YBK ⑨ | 1 | | 32 | XY ① | Brown/White | 0.3sq | | | | | | | | | |
| MB- | | 2 | | 34 | | Gray/White | twisted pair | | | | | | | | | |
| HLIM | | | | 10 | | Green | | | | | | | | | | |
| GND24 | | | | 11 | | | | | | | | | | | | |
| HLIM | | | | 28 | | Green | | | | | | | | | | |
| GND24 | | | | 29 | | | | | | | | | | | | |
| U | XM ⑬ | 1 | | 2 | XM ③ | 1 | 0.75sq | U | ZM ⑯ | 1 | | 2 | ZM ⑤ | 1 | 0.75sq | |
| V | | 2 | | 3 | | 2 | 0.75sq | V | | 2 | | 4 | | 2 | 0.75sq | |
| W | | 3 | | 4 | | 3 | 0.75sq | W | | 3 | | 3 | | 3 | 0.75sq | |
| FG | Ring-tongue terminal | 4 | | 1 | | Yellow/Green | 0.75sq | FG | Ring-tongue terminal ⑰ | 4 | | 1 | | Yellow/Green | 0.75sq | |
| U | YM ⑭ | 1 | | 2 | YM ④ | 4 | 0.75sq | | | | | | | | | |
| V | | 2 | | 3 | | 5 | 0.75sq | | | | | | | | | |
| W | | 3 | | 4 | | 6 | 0.75sq | | | | | | | | | |
| FG | Ring-tongue terminal ⑮ | 4 | | | | | | | | | | | | | | |



3-axis robot cable (For TRCX controller)

| Signal | Connector | No | Connection | No | Connector | Color/No. | Wire | Signal | Connector | No | Connection | No | Connector | Color/No. | Wire | |
|-------------------------|-----------|----|------------|----|-----------|--------------|--------------|-------------------------|-------------------|--------|------------|--------|-----------------|--------------|--------------|--|
| Resolver S2 | XP ⑥ | 1 | | 1 | XY ① | Blue | 0.3sq | Resolver S2 | ZP (RP) ⑩ | 1 | | 1 | ZR ② | Blue | 0.3sq | |
| S4 | | 2 | | 2 | | Orange | twisted pair | S4 | | 2 | | Orange | | twisted pair | | |
| S1 | | 3 | | 3 | | Green | 0.3sq | S1 | | 3 | | Green | | 0.3sq | | |
| S3 | | 4 | | 4 | | Brown | twisted pair | S3 | | 4 | | Brown | | twisted pair | | |
| R1 | | 5 | | 5 | | Gray | 0.3sq | R1 | | 5 | | Gray | | 0.3sq | | |
| R2 | | 6 | | 6 | | Red | twisted pair | R2 | | 6 | | Red | | twisted pair | | |
| DG | | 7 | | 7 | | Green | 0.3sq | DG | | 7 | | Green | | 0.3sq | | |
| Brake MB+ | XBK ⑦ | 1 | | 14 | XY ① | Black | 0.3sq | Brake MB+ | ZBK (RBK) ⑪ | 1 | | 14 | ZR ② | Black | 0.3sq | |
| MB- | | 2 | | 16 | | Yellow | twisted pair | MB- | | 2 | | Yellow | | twisted pair | | |
| Resolver S2 | YP ⑧ | 1 | | 19 | XY ① | Pink | 0.3sq | Sensor 24V | ORG ⑧ | 1 | | 9 | ZR ② | Red/White | 0.3sq | |
| S4 | | 2 | | 20 | | Purple | twisted pair | ORG | | 2 | | 12 | | Yellow/Black | 0.3sq | |
| S1 | | 3 | | 21 | | White | 0.3sq | GND24 | | 3 | | 13 | | Pink/Black | twisted pair | |
| S3 | | 4 | | 22 | | Blue/Red | twisted pair | HLIM | | 10 | Green | | | | | |
| R1 | | 5 | | 23 | | Orange/White | 0.3sq | GND24 | | 11 | | | | | | |
| R2 | | 6 | | 24 | | Green/White | twisted pair | HLIM | | 28 | Green | | | | | |
| DG | | 7 | | 25 | | Green | 0.3sq | GND24 | | 29 | | | | | | |
| Brake MB+ | YBK ⑨ | 1 | | 32 | XY ① | Brown/White | 0.3sq | U | ZM (RM) ⑬ | 1 | | 2 | ZM (RM) ⑤ | 1 | 0.75sq | |
| MB- | | 2 | | 34 | | Gray/White | twisted pair | V | | 2 | | 0.75sq | | | | |
| HLIM | | | | 10 | | Green | | 3 | | 0.75sq | | | | | | |
| GND24 | | | | 11 | | | | 4 | | 0.75sq | | | | | | |
| HLIM | | | | 28 | | Green | | 1 | Yellow/Green | 0.75sq | | | | | | |
| GND24 | | | | 29 | | | | | | | | | | | | |
| U | XM ⑬ | 1 | | 2 | XM ③ | 1 | 0.75sq | W | | | | | | | | |
| V | | 2 | | 3 | | 2 | 0.75sq | FG Ring-tongue terminal | 4 | 1 | | | | | | |
| W | | 3 | | 4 | | 3 | 0.75sq | U | | | | | | | | |
| FG Ring-tongue terminal | | 4 | | 1 | | Yellow/Green | 0.75sq | V | | | | | | | | |
| U | YM ⑭ | 1 | | 2 | YM ④ | 4 | 0.75sq | W | | | | | | | | |
| V | | 2 | | 3 | | 5 | 0.75sq | FG Ring-tongue terminal | 4 | | | | | | | |
| W | | 3 | | 4 | | 6 | 0.75sq | | | | | | | | | |
| FG Ring-tongue terminal | | 4 | | 1 | | Yellow/Green | 0.75sq | | | | | | | | | |

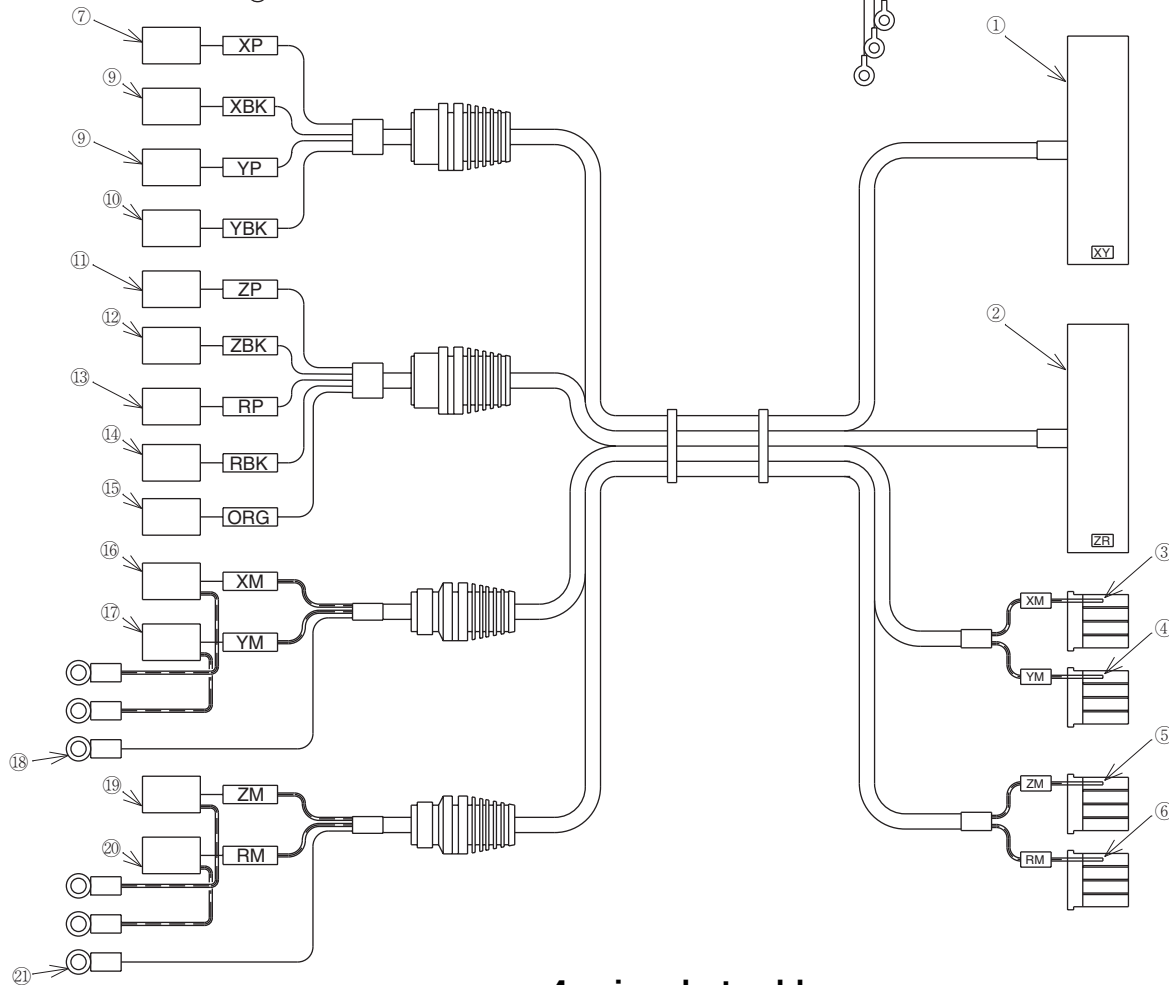


3-axis robot cable (For RCX40 controller)

Chapter 5 Specifications

| Signal | Connector | No | Connection | No | Connector | Color/No. | Wire |
|---|-----------|----|------------|----------------------|-----------|--------------|--------------|
| Resolver S2 S4 S1 S3 R1 R2 DG | XP ⑦ | 1 | | 1 | XY ① | Blue | 0.3sq |
| | | 2 | | 2 | | Orange | twisted pair |
| | | 3 | | 3 | | Green | 0.3sq |
| | | 4 | | 4 | | Brown | twisted pair |
| | | 5 | | 5 | | Gray | 0.3sq |
| | | 6 | | 6 | | Red | twisted pair |
| | | 7 | | 7 | | Green | 0.3sq |
| Brake MB+ MB- | XBK ⑧ | 1 | | 14 | XY ① | Black | 0.3sq |
| | | 2 | | 16 | | Yellow | twisted pair |
| Resolver S2 S4 S1 S3 R1 R2 DG | YP ⑨ | 1 | | 19 | XY ① | Pink | 0.3sq |
| | | 2 | | 20 | | Purple | twisted pair |
| | | 3 | | 21 | | White | 0.3sq |
| | | 4 | | 22 | | Blue/Red | twisted pair |
| | | 5 | | 23 | | Orange/White | 0.3sq |
| | | 6 | | 24 | | Green/White | twisted pair |
| | | 7 | | 25 | | Green | 0.3sq |
| Brake MB+ MB- | YBK ⑩ | 1 | | 32 | XY ① | Brown/White | 0.3sq |
| | | 2 | | 34 | | Gray/White | twisted pair |
| HLIM GND24 HLIM GND24 | | | | 10 11 28 29 | | Green | |
| U V W | XM ⑬ | 1 | | 2 | XM ③ | 1 | 0.75sq |
| | | 2 | | 3 | | 2 | 0.75sq |
| | | 3 | | 4 | | 3 | 0.75sq |
| FG Ring-tongue terminal ⑬ | | 4 | | 1 | | Yellow/Green | 0.75sq |
| U V W | YM ⑭ | 1 | | 2 | YM ③ | 4 | 0.75sq |
| | | 2 | | 3 | | 5 | 0.75sq |
| | | 3 | | 4 | | 6 | 0.75sq |
| FG Ring-tongue terminal ⑭ | | 4 | | | | | |

| Signal | Connector | No | Connection | No | Connector | Color/No. | Wire |
|---|-----------|----|------------|----|-----------|--------------|--------------|
| Resolver S2 S4 S1 S3 R1 R2 DG | ZP ⑪ | 1 | | 1 | ZR ② | Blue | 0.3sq |
| | | 2 | | 2 | | Orange | twisted pair |
| | | 3 | | 3 | | Green | 0.3sq |
| | | 4 | | 4 | | Brown | twisted pair |
| | | 5 | | 5 | | Gray | 0.3sq |
| | | 6 | | 6 | | Red | twisted pair |
| | | 7 | | 7 | | Green | 0.3sq |
| Brake MB+ MB- | ZBK ⑫ | 1 | | 14 | ZR ② | Black | 0.3sq |
| | | 2 | | 16 | | Yellow | twisted pair |
| Resolver S2 S4 S1 S3 R1 R2 DG | RP ⑬ | 1 | | 19 | ZR ② | Pink | 0.3sq |
| | | 2 | | 20 | | Purple | twisted pair |
| | | 3 | | 21 | | White | 0.3sq |
| | | 4 | | 22 | | Blue/Red | twisted pair |
| | | 5 | | 23 | | Orange/White | 0.3sq |
| | | 6 | | 24 | | Green/White | twisted pair |
| | | 7 | | 25 | | Green | 0.3sq |
| Brake MB+ MB- | RBK ⑭ | 1 | | 32 | ZR ② | Brown/White | 0.3sq |
| | | 2 | | 34 | | Gray/White | twisted pair |
| Sensor 24V ORG GND24 | ORG ⑮ | 1 | | 27 | ZR ② | Red/White | 0.3sq |
| HLIM GND24 | | 2 | | 30 | | Yellow/Black | 0.3sq |
| HLIM GND24 | | 3 | | 31 | | Pink/Black | twisted pair |
| U V W | ZM ⑰ | 1 | | 2 | ZM ⑤ | 1 | 0.75sq |
| | | 2 | | 3 | | 2 | 0.75sq |
| | | 3 | | 4 | | 3 | 0.75sq |
| FG Ring-tongue terminal ⑰ | | 4 | | 1 | | Yellow/Green | 0.75sq |
| U V W | RM ⑱ | 1 | | 2 | RM ⑥ | 4 | 0.75sq |
| | | 2 | | 3 | | 5 | 0.75sq |
| | | 3 | | 4 | | 6 | 0.75sq |
| FG Ring-tongue terminal ⑱ | | 4 | | | | | |



4-axis robot cable

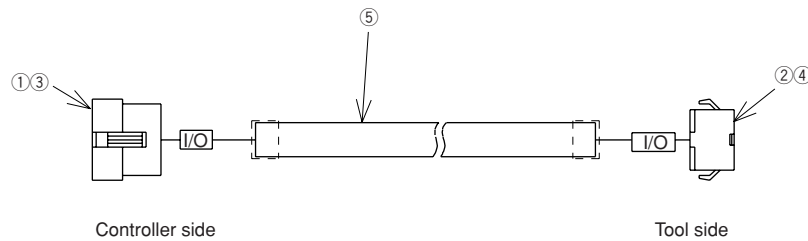
1-2 User I/O cable

The cartesian robot XY-X Series cable carrier type have a signal wire that can be used freely from the X-axis wiring box to the final axis wiring box.

| Part No. | Part name | Part No. | Qty. |
|----------|--------------|----------------|------|
| 1 | SM connector | SMR-10V-B | 1 |
| 2 | SMconnector | SMP-10V-BC | 1 |
| 3 | Contact | SYM-001T-0.6 | 10 |
| 4 | Contact | SHF-001T-0.8BS | 10 |
| 5 | Cable | | 1 |

| Signal | Connector | NO | NO | Connector | Remarks |
|---------------------|-----------|----|----|-----------|---------|
| General-purpose I/O | I/O ① | 1 | 1 | I/O ② | Red |
| | | 2 | 2 | White | |
| | | 3 | 3 | Green | |
| | | 4 | 4 | White | |
| | | 5 | 5 | Yellow | |
| | | 6 | 6 | White | |
| | | 7 | 7 | Blue | |
| | | 8 | 8 | White | |
| | | 9 | 9 | Purple | |
| | | 10 | 10 | White | |

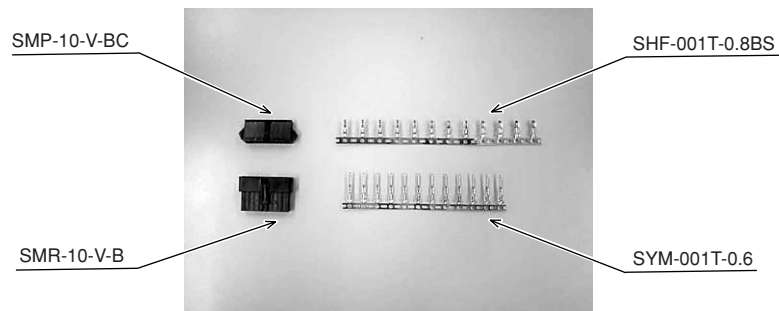
0.3sq twisted pair



Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed.

These can be used freely by the user.

| | | | |
|---------------------------|----------------------|-----|----------------|
| Maker | J.S.T. Mfg Co., Ltd. | | |
| Connector type | SMR-10V-B | Pin | SYM-001T-0.6 |
| | SMP-10V-BC | | SHF-001T-0.8BS |
| Recommended crimping tool | YC-122R | | |



MEMO

CHAPTER 6



PXYX

| | | |
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| 1-2 | Installation bolt nominal length | 6-1 |
| 1-3 | Tightening torque | 6-1 |
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MEMO

1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

To install the PXYX robot, tap holes into the installation base and secure the robot to the base with M4 bolts from the inside of the robot.

1-1 Installation bolt types

- Use the following type of installation bolt.
Hexagon socket head Cap screw M4 Strength 8.8T

1-2 Installation bolt nominal length

⚠ CAUTION

Do not use washers or spring washers with the tightening bolt.
The bolt head could interfere with the linear guide's bearings and be damaged.

If the installation base is made of steel, secure 1D or more (4mm or more for M4) for the screw fitting length. When using aluminum, secure 1.5D or more (6mm or more for M4). The rail thickness is 5mm. (Refer to Fig. 6-1.)

Recommended nominal length

| | |
|--|--------------|
| When installation base is made of steel | 10mm or more |
| When installation base is made of aluminum | 12mm or more |

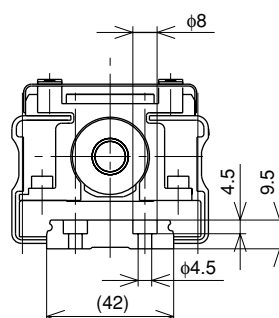


Fig. 6-1

1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.
Recommended torque 2.9N·m to 4.4N·m (30kgf·cm to 45kgf·cm)

1-4 Installation methods

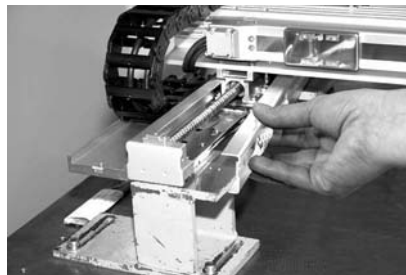
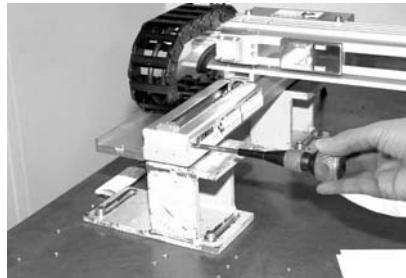
⚠ WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

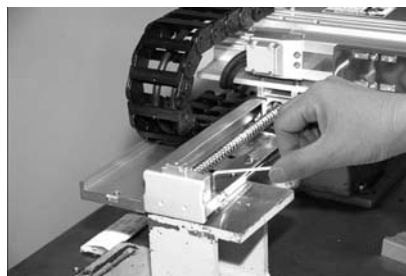
⚠ CAUTION

Take care not to catch the shutter when installing the side covers.

- 1) Tap M4 coarse screw thread holes into the installation base where the robot is to be installed.
Refer to the XY-X Series catalog for the hole positions.
- 2) Remove the M3 small screw fixing the X-axis side cover, and remove the side cover.



- 3) Fix the robot onto the installation base with the designated bolt.



- 4) Return the side covers to the original state after installing the robot.

2 Protective Connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground terminal with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground terminal is located on the end face of the X-axis wiring box. (Refer to Fig. 6-2.)

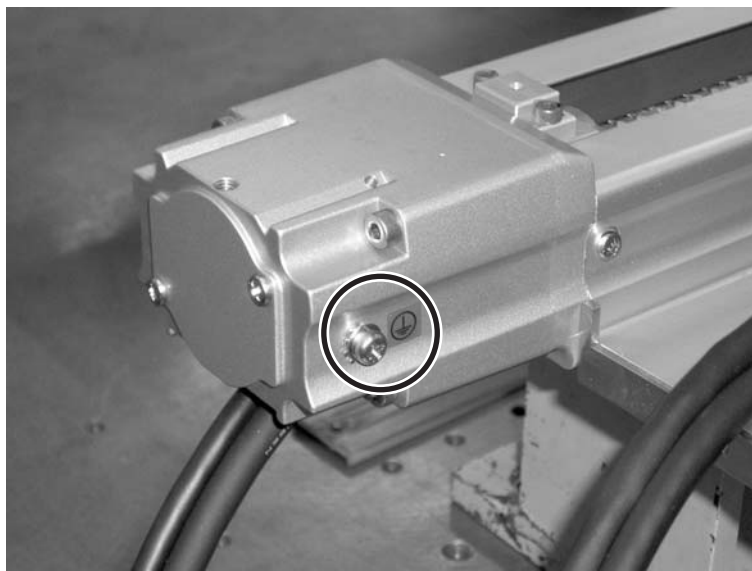


Fig. 6-2

2-2 Ground wire

Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

2-3 Wiring method

⚠ WARNING

Accurately insert the lock washer between the ring-tongue terminal and robot.

Proper continuity may not be secured if the lock washer is dislocated.

Connect the ground wire to the ground terminal located on the end face of the X-axis wiring box.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten them. (Refer to Fig. 6-3)

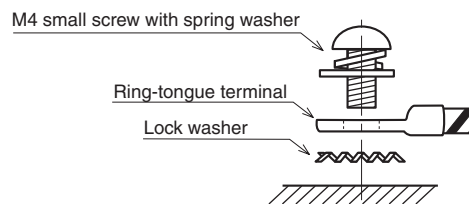


Fig. 6-3

3 Installing the Tool

⚠ WARNING

Always turn the controller power OFF before installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

Four M4 coarse thread tap holes and two $\phi 3$ reamer holes are opened on the Y-axis slider. (Refer to Fig. 6-4.) Install the user tool onto the Y-axis slider using these holes.

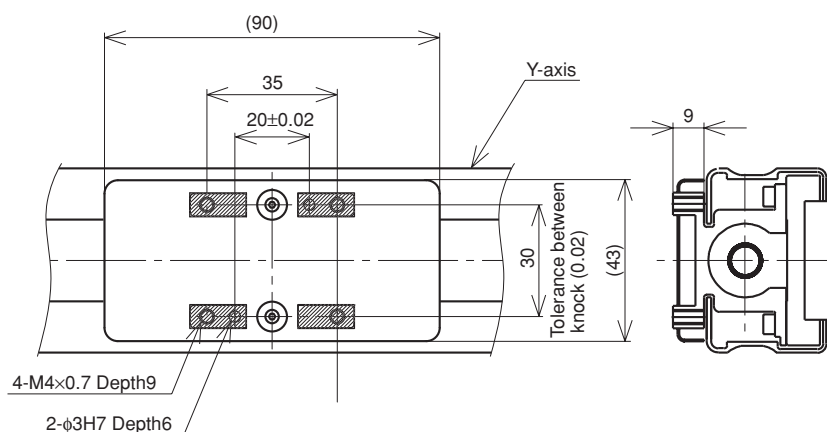


Fig. 6-4

NOTE

The dimensions shown with (90) and (43) indicate the maximum outline dimensions of the stainless cover covering the slider. The actual tool installation surface is the shaded section shown above.

Select the screw under head length so that the fitting length of the screw fixing the tool is 5mm or more, 9mm or less.

⚠ CAUTION

If the screw's fitting length is less than 5mm, the screw threads could be damaged during tightening. If the fitting length exceeds 9mm, the screw end could contact the cover and cause trouble.

4 User Wiring and User Piping

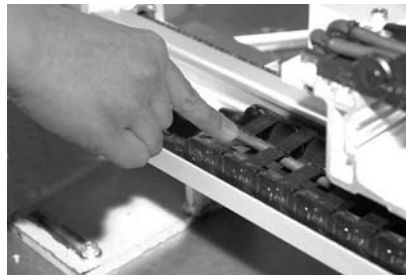
⚠ WARNING

Always turn off the controller before wiring and piping to prevent electrical shocks.

The methods for leading the wiring and piping to the tool are described in this section.

A cable carrier is provided as a standard between the X-Y axes. Carry out wiring and piping using this cable carrier.

- 1) Open the X-axis wiring box cover.
- 2) Rubber grommets are attached to the X-axis wiring box. Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through.
- 3) Pass the cables and air tubes through the cable carrier. These can be stored easily just by pressing on the outside of the cable carrier.



- 4) Open the Y-axis wiring box cover.
- 5) Rubber grommets are also attached to the Y-axis wiring box. Open holes in these grommets, and pass the cables and air tubes through.

⚠ CAUTION

1. The wires could be damaged if the Insulock ties are tightened too much.
2. Manually move the robot by the full stroke before or after fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.

- 6) When completed with the wiring, use the comb section at both ends of the cable carrier, and fix the harness and air tubes with Insulock ties.



- 7) When completed with the wiring, reattach the cover to the wiring box.

Cable carrier specifications

CAUTION

When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area.

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

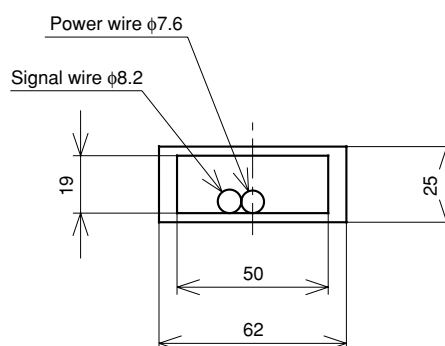


Fig. 6-5

5 Periodic Inspections

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

5-1 Replenishing grease to the linear guide

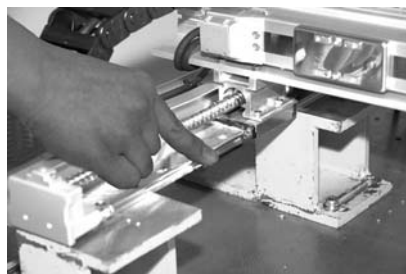
Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the side cover. (Refer to 1-4. Installation.)
- 4) Apply grease onto the linear guide with a finger.



- 5) After greasing, return the side cover to the original position.

5-2 Replenishing grease to the ball screw

The X and Y axes use a ball screw. Grease must be replenished to this ball screw periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the side cover. (Refer to 1-4. Installation.)
- 4) Apply grease onto the ball screw's shaft with a finger.
Wipe off any excessive grease.



- 5) After greasing, return the side cover to the original position.

MEMO

CHAPTER 7

FXYX

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MEMO

1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

To install the FXYX robot, tap holes into the installation base and secure the robot to the base with M6 bolts from the inside of the robot.

1-1 Installation bolt types

- Use the following type of installation bolt.
Hexagon socket head cap screw M6 Strength 8.8T

1-2 Installation bolt nominal length

⚠ CAUTION

Do not use washers or spring washers with the tightening bolt.
The bolt head could interfere with the linear guide's bearings and be damaged.

If the installation base is made of steel, secure 1D or more (6mm or more for M6) for the screw fitting length. When using aluminum, secure 1.5D or more (9mm or more for M6). The frame thickness is 24mm. (Refer to Fig. 7-1.)

Recommended nominal length 35mm or more

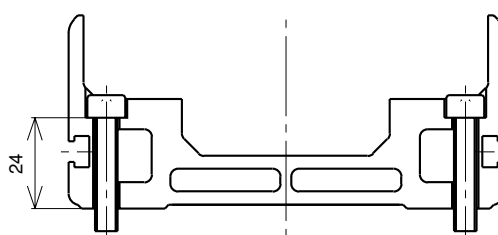


Fig. 7-1

1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

Recommended torque 9.8N·m to 12.7N·m (100kgf·cm to 130kgf·cm)

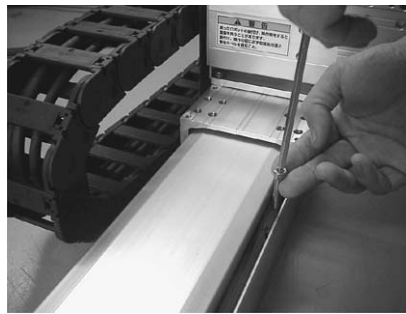
1-4

Installation methods

⚠ WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

- 1) Tap M6 coarse screw thread holes into the installation base where the robot is to be installed.
Refer to the XY-X Series catalog for the hole positions.
- 2) Fix the robot onto the installation base with the designated bolt from within the clearance between the X-axis stroke cover and frame.



NOTE

Remove the stroke cover and carry out the work if it is difficult to install the robot.

2 Protective Connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground terminal with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground terminal is located on the end face of the X-axis wiring box. (Refer to Fig. 7-2.)

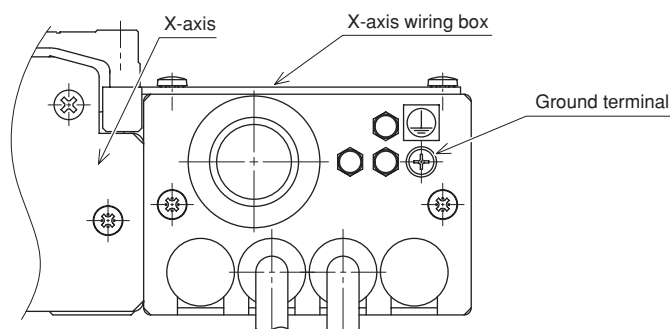


Fig. 7-2

2-2 Ground wire

Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

2-3 Wiring method

⚠ WARNING

Accurately insert the lock washer between the ring-tongue terminal and robot.

Proper continuity may not be secured if the lock washer is dislocated.



Connect the ground wire to the ground terminal located on the end face of the X-axis wiring box.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 7-3)

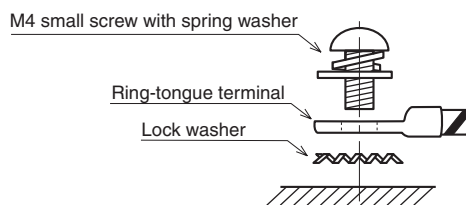


Fig. 7-3

3 Installing the Tool

⚠ WARNING

Always turn the controller power OFF before Installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

3-1 Arm type 2-axis model

Eight M5 coarse thread tap holes and two $\phi 5$ reamer holes are opened on the Y-axis slider. (Refer to Fig. 7-4.) Install the user tool onto the Y-axis slider using these holes.

M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

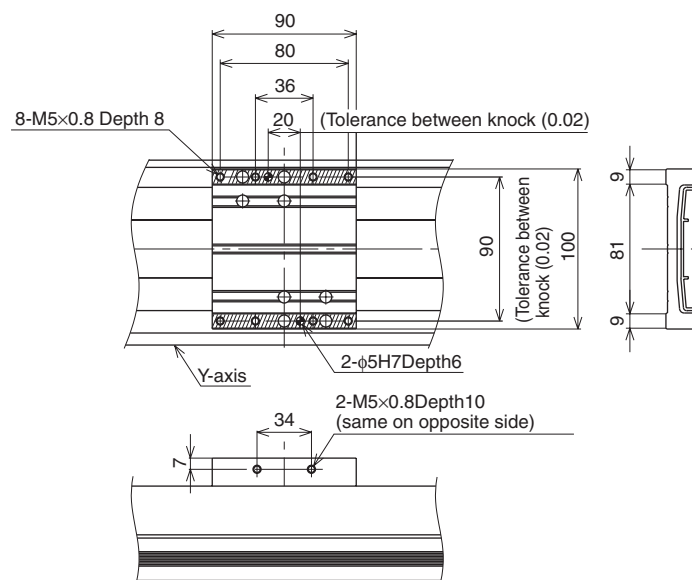


Fig. 7-4 Arm type

⚠ CAUTION

If the fitting length is less than 8mm, the threads could be damaged during tightening. If the fitting length exceeds 12mm, the bolt end could contact the bottom.

NOTE

There is a step on the top of the slider. The actual tool installation surface is the shaded section shown above.

Select the nominal length of the tool fixing bolt so that the fitting length of the screw fixing the tool is 8mm or more, 12mm or less.

3-2 ZS (3rd-axis option)

⚠ WARNING

Use the tap hole on the end of the shaft only to prevent the tool from dislocating.

Do not use only this hole to install the tool. The tool could dislocate and fly off the installation section during robot operation.

If the ZS unit is attached for the 3rd-axis, install the tool on the ZS shaft as shown below. Use the $\phi 12$ section on the shaft, and fix the tool with a bolt coupling or split clamp.

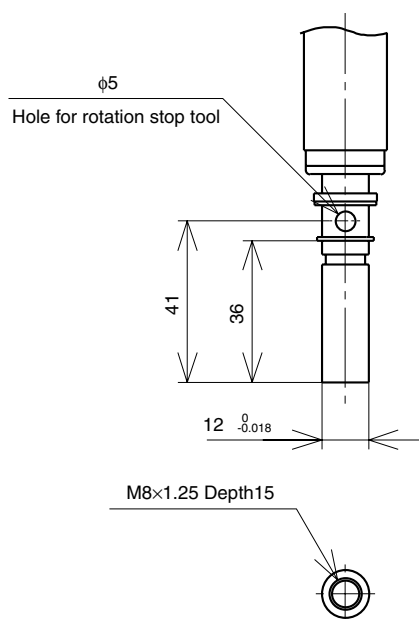


Fig. 7-6 ZS

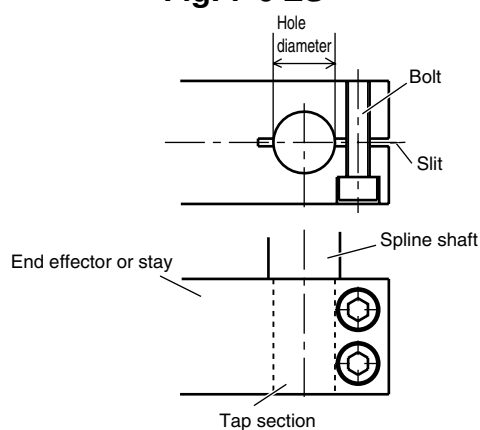


Fig. 7-7

| | | |
|-------------------|--------------------|--|
| Example : | For split clamp | |
| Recommended bolt | M4 or more | |
| Quantity | 2 or more | |
| Tightening torque | 4.5N·m (46kgfm) | |
| Hole diameter | $\phi 12^{+0.018}$ | |

4 User Wiring and User Piping

⚠ WARNING

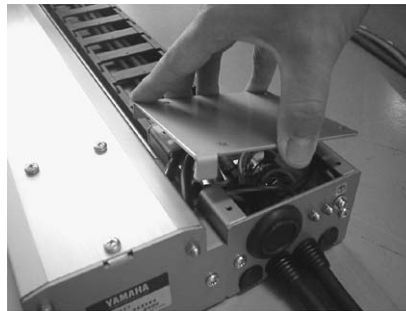
Always turn off the controller before wiring and piping to prevent electrical shocks.

4-1 Cable carrier type

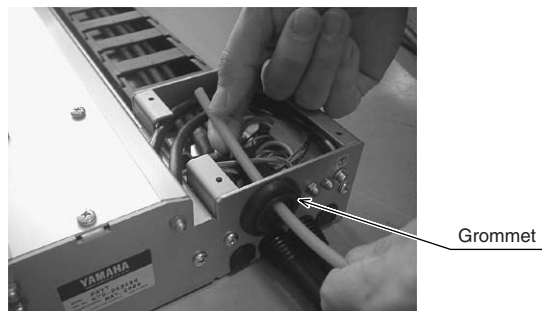
A cable carrier is mounted as a standard between the X and Y axes. When using three axes, a cable carrier is also provided between the Y and Z axes. Lay the wiring and piping to the tool using these ducts. A 0.3sq 10-core flexible cable is wired from the X-axis wiring box to the final axis' wiring box, and can be used freely. (Refer to the "User wiring specifications" at the end of this section for details.) The wiring and piping methods for a 2-axis arm type are explained below as an example.

4-1-1 Example of wiring and piping methods using cable carrier

- 1) Remove the four M4 small screws and open the X-axis wiring box cover.



- 2) Rubber grommets are attached to the end face of X-axis wiring box. Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through.



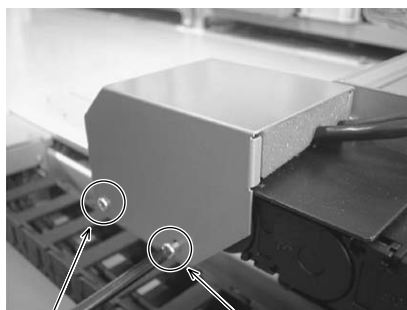
- 3) Pass the cables and air tubes from the X-axis wiring box outlet through the cable carrier.



The cable carrier has an outer lid that can be opened and closed easily. Use a flat-tip screwdriver to open the lid. Press this lid in to close it. Open and close this lid as necessary.



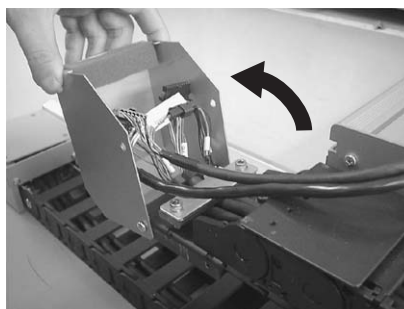
- 4) Remove the two M4 small screws on the Y-axis wiring box, and loosen two places.



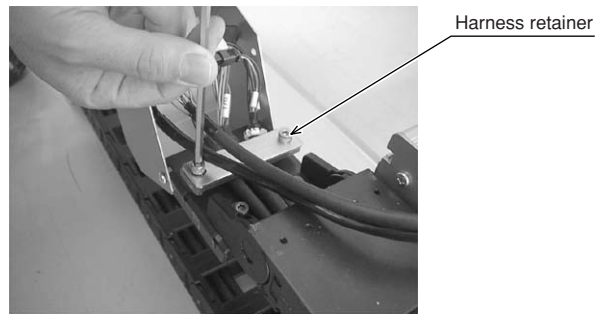
Loosen
(same on opposite side)

Remove
(same on opposite side)

- 5) Using the small screws loosened on the Y-axis wiring box cover as a support point, turn and open the box.



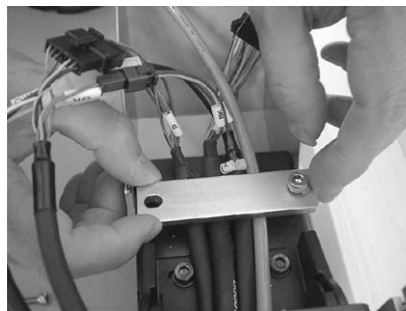
- 6) Remove the harness retainer from the Y-axis wiring box. (Two hexagon socket bolts M5)



7) **CAUTION**

1. The wires could be damaged if the harness retainer is tightened too much.
2. Manually move the robot by the full stroke before fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.

Lay the required harness and air tubes, etc., in the Y-axis box, and fix with the harness retainer.



- 8) Assemble the wiring box cover at the original position.

4-1-2 Cable carrier specifications

CAUTION

When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area.

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

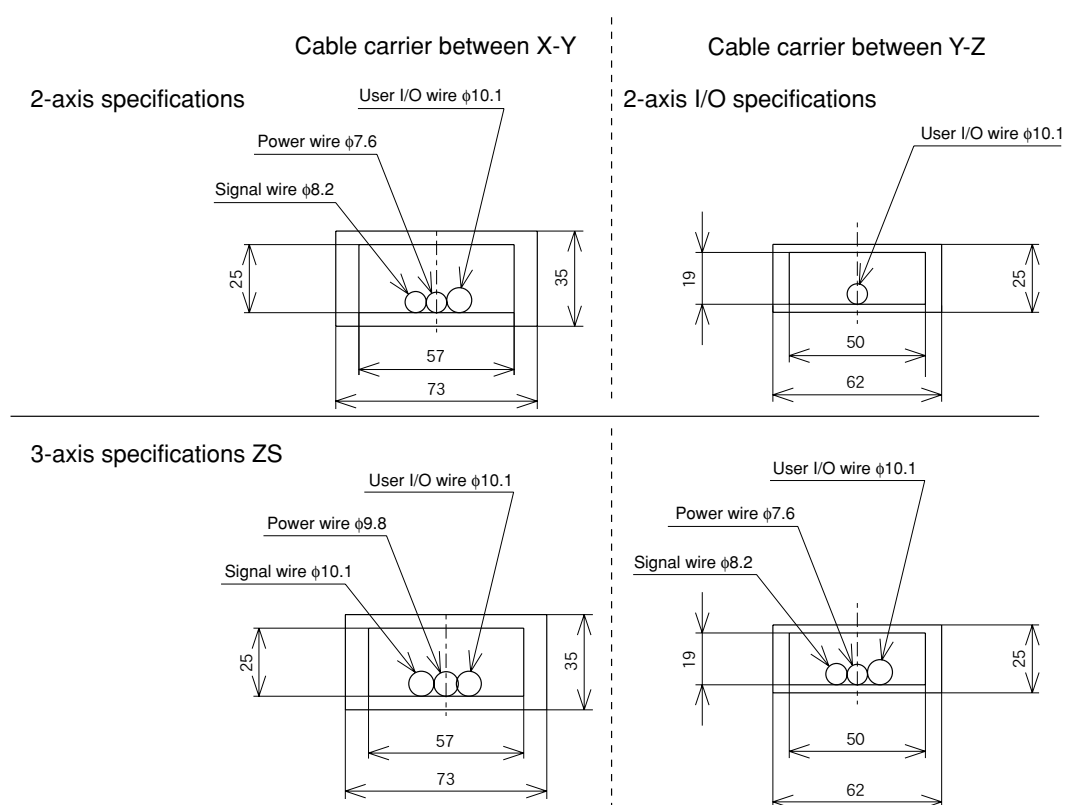


Fig. 7-8

4-1-3 User I/O cable specifications

▲ CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

With the cable carrier models, signal wires ($0.3\text{mm}^2 \times 10$ wires) that can be used freely by the user are laid as a standard between the X-axis wiring box and final axis' wiring box.

Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed. Attach these to the user wiring to eliminate wiring led through the robot.

Crimp the enclosed pins onto the user wiring, and insert into the connector.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

Refer to "1-2. User I/O wiring" in Chapter 5 "Specifications" for details on the wiring specifications.

5 Periodic Inspections

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts, turn OFF the controller, wait for a while and check that the part has cooled.

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

5-1 Replenishing grease to the linear guide

Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

X-axis, Y-axis

- 1) Turn the controller power OFF.
- 2) Place a sign indicating “Work In Progress” so that other operators do not turn the controller power ON.
- 3) Remove the axis stroke cover when replenishing grease.

- 4) Using a grease gun, replenish grease from the grease nipple installed on the linear guide bearings.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the linear guide bearings and rail.

The X-axis has four bearings, and the Y-axis has two bearings. Replenish grease to all bearings.

Wipe off any excessive grease that has seeped out to the rail.

Recommended grease gun MG70 (THK N-type nozzle)

- 5) After greasing, return the each cover to the original position.

5-2 Replenishing grease to the ball screw

The X-axis, Y-axis and Z-axis use a ball screw. Grease must be replenished to this ball screw periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
 Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

X-axis

CAUTION

Always remove the grease nipple after completing the work. Damage or positional deviation could occur if the robot is operated with the grease nipple installed.

- 1) Prepare the following recommended grease nipple beforehand.
Recommended grease nipple A-M6X1 type (JIS B1575)

- 2) Turn the controller power OFF.
- 3) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 4) Remove the stroke cover.
- 5) Install the grease nipple onto the ball screw flange.
- 6) Replenish the grease using the grease gun.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the ball screw nut and screw.

Wipe off any excessive grease.

Recommended grease gun MG70 (THK N-type nozzle)

- 7) Remove the grease nipple.
- 8) Return the stroke cover to the original position.

Y-axis

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the stroke cover.
- 4) Apply grease to the ball screw shaft with a finger.
Wipe off any excessive grease.
- 5) Return the stroke cover to the original position.

Z-axis (ZS)

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the screws (M4, 6 screws) fixing the cover, and pull the cover upward and off.

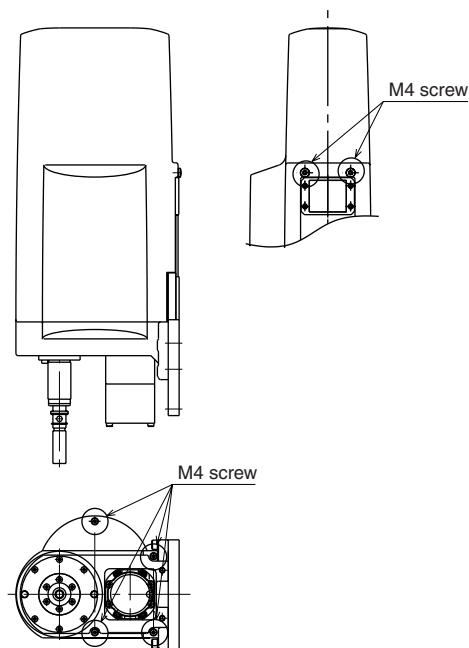


Fig. 7-9 ZS

- 4) Wipe off any excessive grease adhered on the ball screw shaft and ball spline shaft.
- 5) Apply a thin coat of grease on the screw shaft with a finger.
- 6) Return the cover to the original position.

CHAPTER 8

SXYX

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1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

The SXYX is installed with one of the following two methods.

Method A : Open through holes on the installation base and install with M6 bolts from below.

(M6 tap holes are opened on the bottom of the robot.)

Method B : Tap holes into the installation base and secure the robot with M6 bolts from the inside of the robot.

1-1 Installation bolt types

- Use the following type of installation bolt.
Hexagon socket head cap screw M6 Strength 8.8T

1-2 Installation bolt nominal length

⚠ CAUTION

Do not use washers or spring washers with the tightening bolt.
The bolt head could interfere with the linear guide's bearings and be damaged.

- When using method A, determine the nominal length so that the length of the screw from the robot bottom is 9mm or more, 27mm or less. (Refer to right side of Fig. 8-1.)
- When using method B, if the installation base is made of steel, secure 1D or more (6mm or more for M6) for the installation base's screw fitting length. When made of aluminum, secure 1.5D or more (9mm or more for M6). (Refer to left side of Fig. 8-1.)

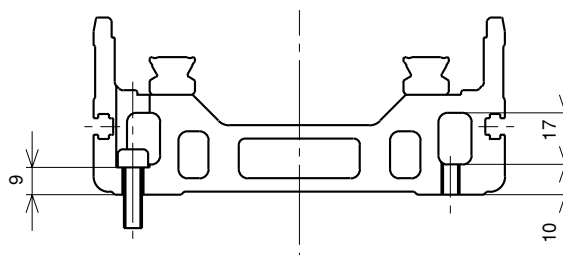


Fig. 8-1

1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

Recommended torque 9.8N·m to 12.7N·m (100kgf·cm to 130kgf·cm)

1-4 Installation methods

⚠ WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

■ Method A

- 1) Open a $\phi 6.5$ through hole on the installation base's robot installation surface.
- 2) Set the robot on the installation base and fix with M6 bolts from below.

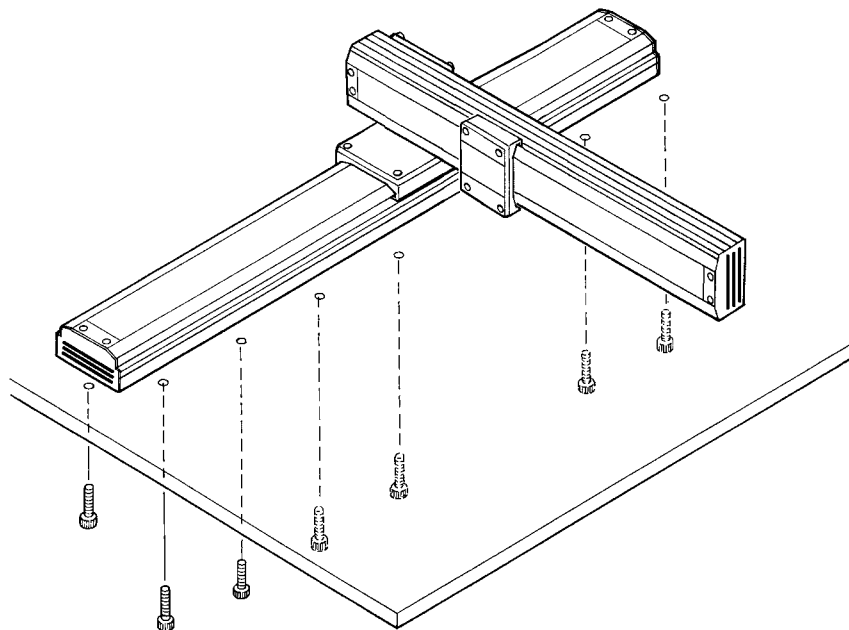


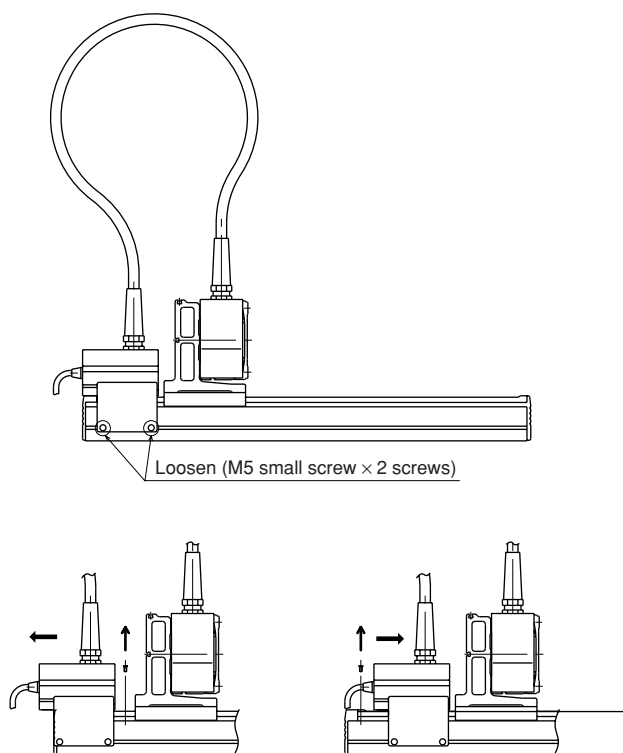
Fig. 8-2

Method B

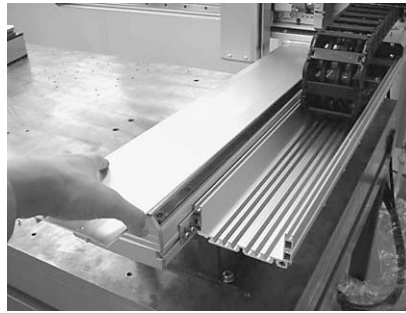
- 1) Tap M6 coarse screw thread holes into the installation base where the robot is to be installed.
Refer to the XY-X Series catalog for the hole positions.
- 2) Remove the countersunk head screws (M4, 5 screws) fixing the X-axis stroke cover.



When using the whipover cable for the arm type, pole type or moving arm type, first loosen the small screws (M5, 2 screws) fixing the X-axis wiring box. Then, slide the X-axis wiring box back and forth, and remove the countersunk head screws. (Refer to Fig. 8-3.)

**Fig. 8-3**

- 3) Remove the X-axis stroke cover.



If the cover is difficult to remove, manually move the Y-axis to the motor side stroke end. The cover will be easier to remove.

- 4) Fix the robot onto the installation base with the designated bolts.



- 5) After installing, return the stroke cover and X-axis wiring box to the original positions.

CAUTION

If the X-axis wiring box was slid in step 2), install so that the end face of the X-axis wiring box and end face of the X-axis are on the same plane. The X-axis wiring box and frame bracket could interfere.

CAUTION

Take care not to catch the wiring when assembling the stroke cover.

2 Protective Connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground terminal with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground tap is located on the inside of the X-axis wiring box.

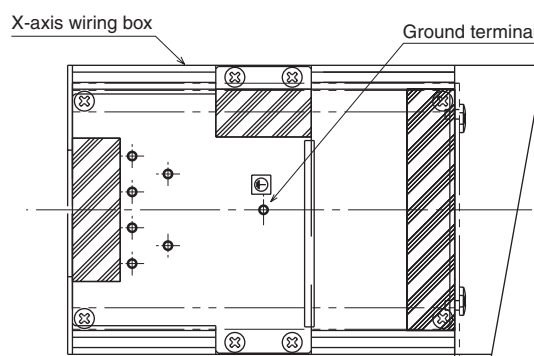


Fig. 8-4 Arm type with cable carrier

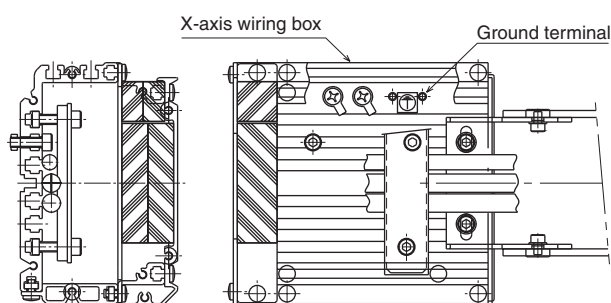


Fig. 8-5 XZ type with cable carrier

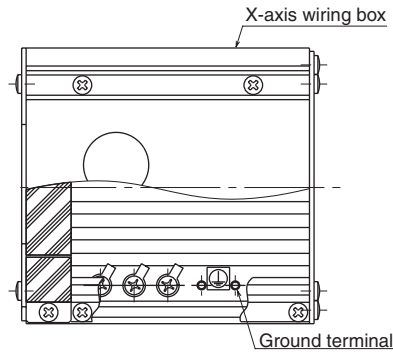


Fig. 8-6 Arm type, moving arm type, gantry type with whipover cable specifications

2-2 Ground wire

Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

2-3 Wiring methods

⚠ WARNING

Accurately insert the lock washer between the ring-tongue terminal and robot.
Proper continuity may not be secured if the lock washer is dislocated.

⚠ CAUTION

Take care not to catch the harness and ground wire from the X-axis with the cover of X-axis wiring box when installing the cover.

2-3-1 Arm type with cable carrier

- 1) Remove the four M4 small screws on the top of the X-axis wiring box, and loosen the M4 small screw on the end face.

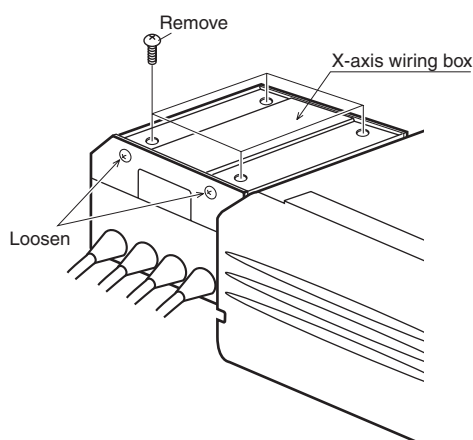


Fig. 8-7

- 2) Open the X-axis wiring box cover.



Lift up the back of the wiring box, push it forward and then pull it upward and off. (Refer to Fig. 8-8.)

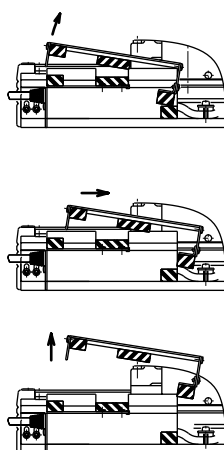
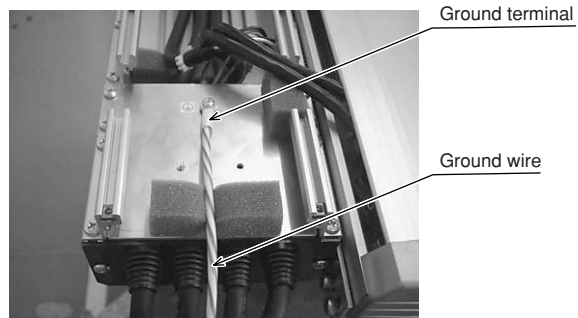


Fig. 8-8 Opening the wiring box

- 3) Connect the ground wire to the ground terminal attached to the top of the X-axis wiring box.



An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 8-9.)

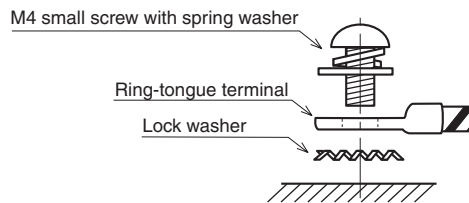


Fig. 8-9

- 4) Return the wiring box cover to the original position following steps 1 and 2 in reverse.
Lead out the ground wire from the user wiring outlet on the end face of the X-axis wiring box.

2-3-2 Arm type with whipover cable, moving arm type, pole type

- 1) Remove the small screws (M4, 4 screws) fixing the X-axis wiring box cover, and remove the cover. (Refer to Fig. 8-10.)

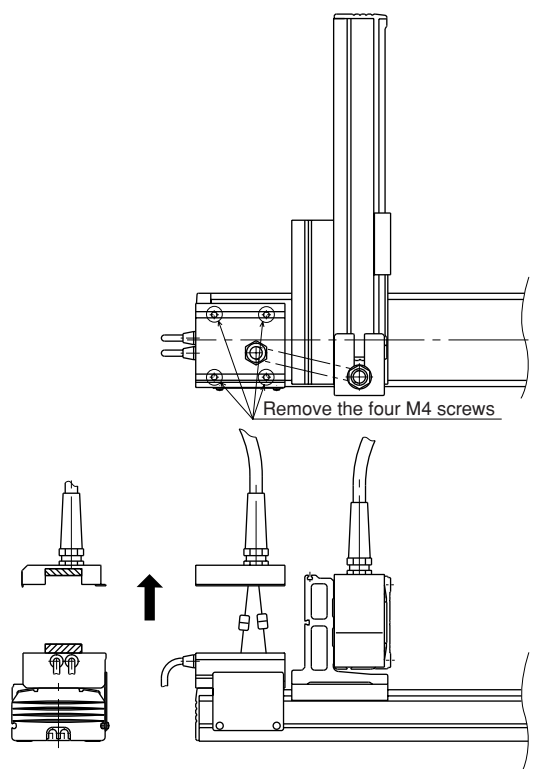


Fig. 8-10

- 2) Fix the ring-tongue terminal of the ground wire to the ground terminal in the X-axis wiring box.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 8-11.)

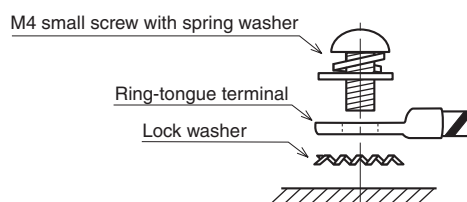


Fig. 8-11

- 3) Return the cover to the original position. Lead out the ground wire from the user wiring outlet on the end face of the X-axis wiring box.

2-3-3 XZ type

- 1) Remove the small screws (M4, 4 screws) fixing the X-axis wiring box cover, and remove the cover. (Refer to Fig. 8-12.)

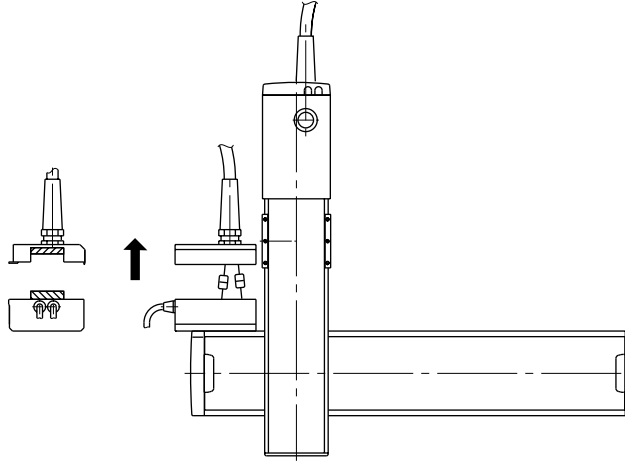


Fig. 8-12

- 2) Fix the ring-tongue terminal of the ground wire to the ground terminal in the X-axis wiring box.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 8-13.)

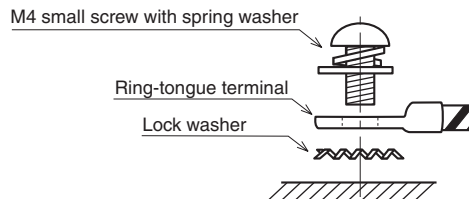


Fig. 8-13

- 3) Return the cover to the original position. Lead out the ground wire from the user wiring outlet on the end face of the X-axis wiring box.

3 Installing the Tool

⚠ WARNING

Always turn the controller power OFF before installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

3-1 Arm type, pole type 2-axis model

Eight M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider. (Refer to Fig. 8-14 and Fig. 8-15.) Install the user tool onto the Y-axis slider using these holes.

M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

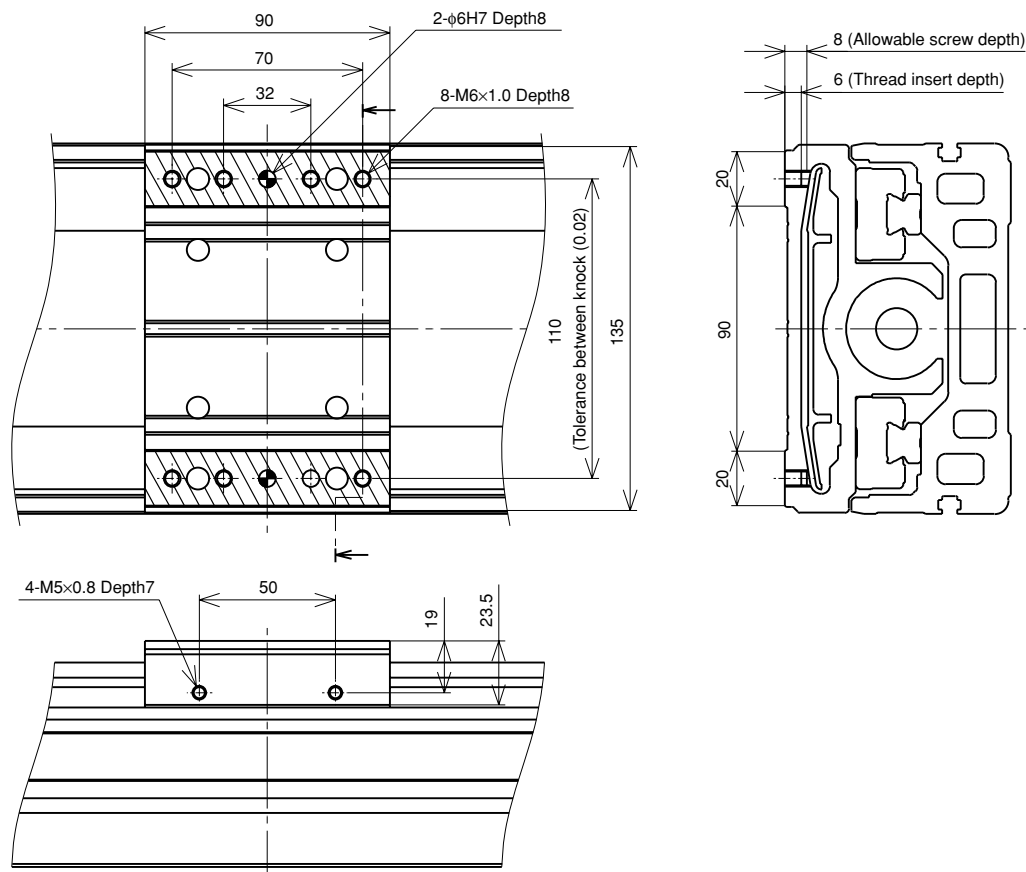


Fig. 8-14 Arm type

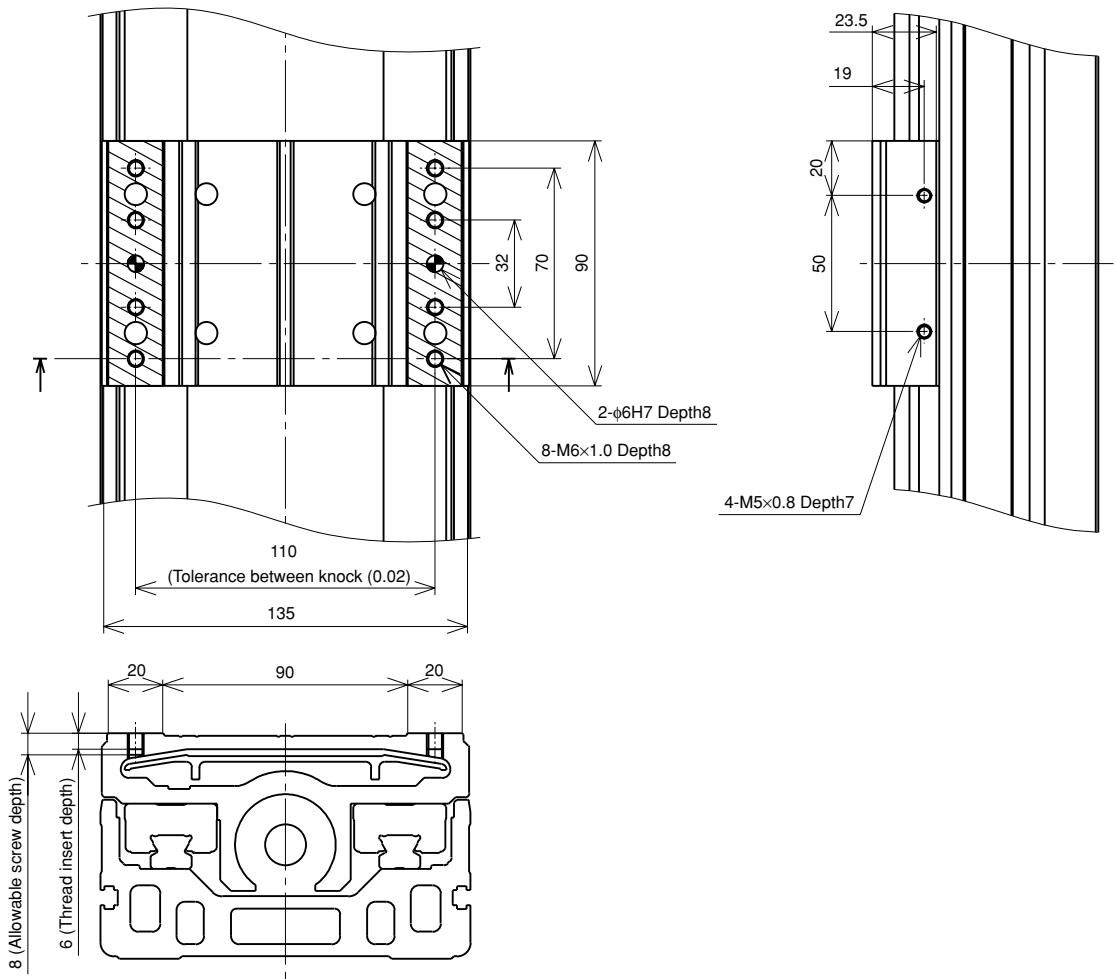


Fig. 8-15 Pole type

CAUTION

If the fitting length is less than 6mm, the threads could be damaged during tightening. If the fitting length exceeds 8mm, the bolt end could contact the bottom.

NOTE

There is a step on the top of the slider. The actual tool installation surface is the shaded section shown above.

Select the nominal length of the tool fixing bolt so that the fitting length of the screw fixing the tool is 6mm or more, 8mm or less.(Refer to the cross-section drawings in Fig. 8-14 and Fig. 8-15.)

3-2 Moving arm type 2-axis model

For the moving arm type, an aluminum bracket is attached to the end of the Y-axis. Install the tool on this bracket.

Twelve M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the bracket.

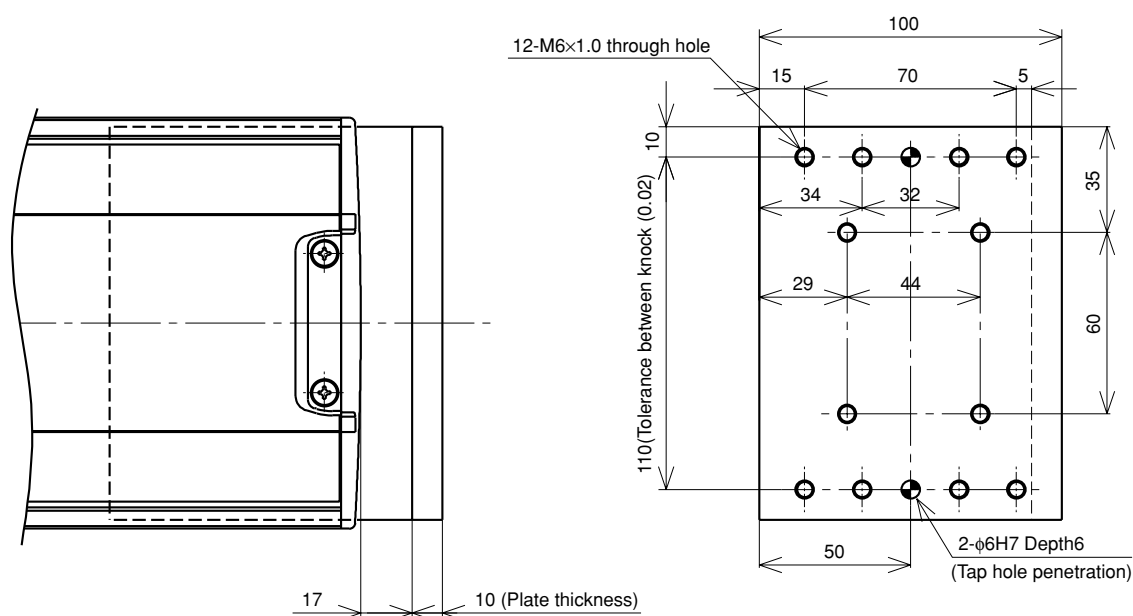


Fig. 8-16 Moving arm type

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the length of the bolt screw is 27mm or more from the installation surface, the screw could contact the Y-axis.

Select the minimum fixing bolt screw length so that the screw fitting length is 9mm or more.

3-3

ZF**(Arm type, moving arm type, 3rd-axis option/XZ type 2-axis model)**

When using the 3rd-axis model with ZF for the 3rd-axis, install the workpiece onto the ZF slider in the following manner.

Four M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the slider's workpiece installation surface. Install the tool using these holes. Four M5 coarse thread tap holes are opened on the slider side. Use these as required to fix light loads other than the tool, such as the wiring retainer.

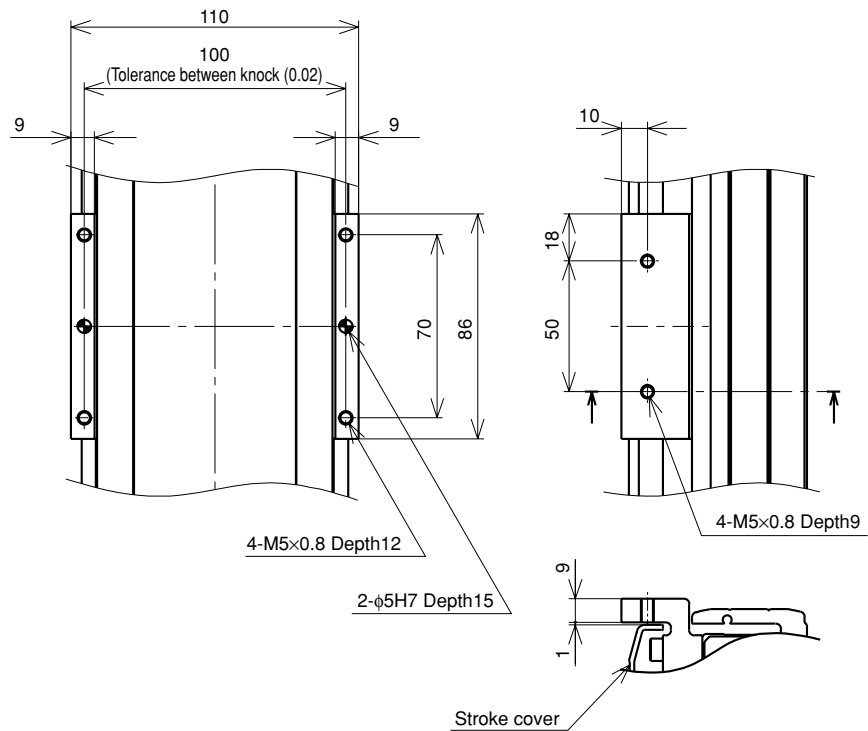


Fig. 8-17 ZF

CAUTION

If the bolt fitting length is 12mm or more from the installation surface, the bolt will contact the bottom.

Select the maximum nominal length of the tool fixing bolt so that the screw fitting length is 12mm or less.

YAMAHA recommends a screw fitting length of 8mm or more.

3-4

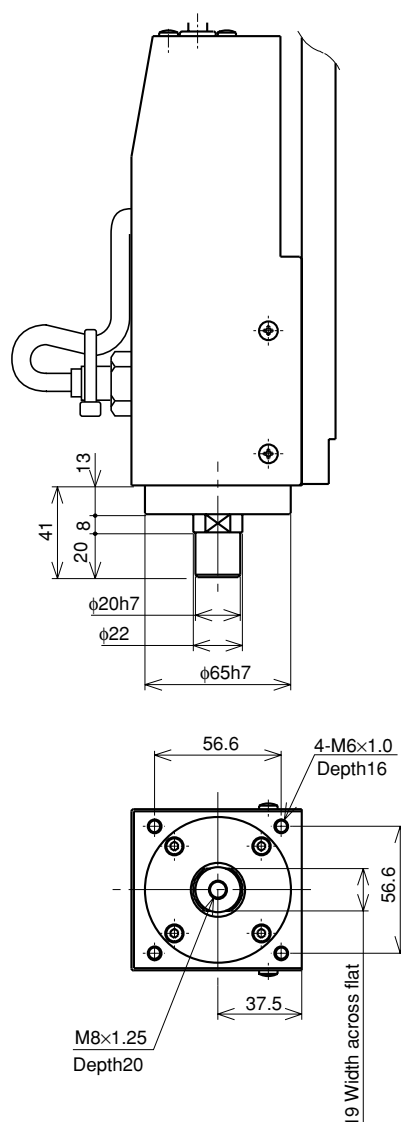
RF**(Arm type, moving arm type, 4th-axis option/XZ type 3rd-axis option)****CAUTION**

Use the tap hole on the end face of the shaft only to prevent the tool from dislocating.

Do not use only this hole to install the tool. The tool could dislocate and fly off the installation section during robot operation.

When using the 4th-axis model with RF (rotary axis unit) for the 4th-axis, install the tool onto the RF shaft in the following manner.

Use the $\phi 20$ section on the shaft, and fix the tool with a bolt coupling or split clamp.

**Fig. 8-18 RF**

3-5

ZS/ZRS (Arm type 3/4-axis option, XZ type 2/3-axis model)

⚠ WARNING

Use the tap hole on the end of the shaft only to prevent the tool from dislocating.

Do not use only this hole to install the tool. The tool could dislocate and fly off the installation section during robot operation.

When the ZS or ZRS unit is attached to the 3rd or 4th-axis, install the tool onto the ZS or ZRS shaft in the following manner. (The ZS and ZRS shaft have the same shape.)

Use the $\phi 12$ section on the shaft, and fix the tool with a bolt coupling or split clamp.

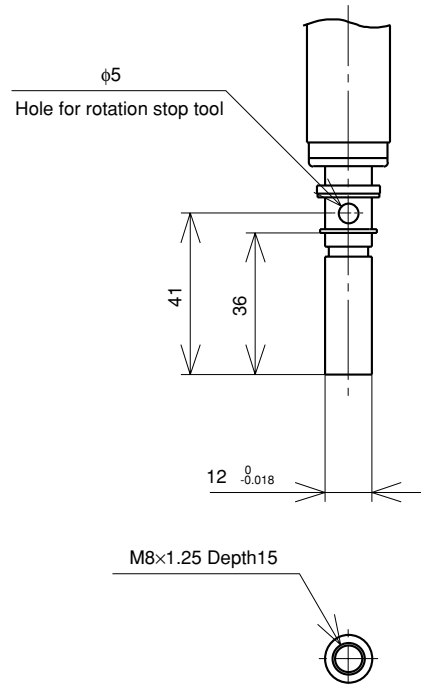


Fig. 8-19 ZS/ZRS

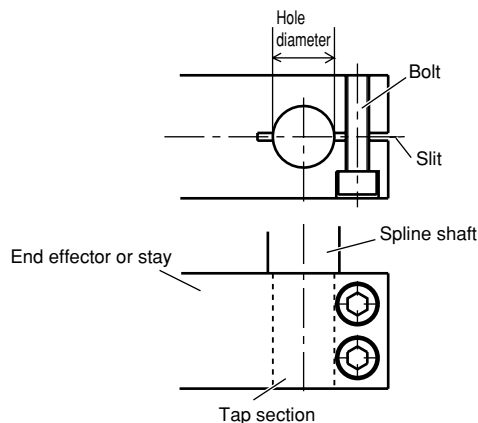


Fig. 8-20

Example : For split clamp

| | |
|-------------------|--------------------|
| Recommended bolt | M4 or more |
| Quantity | 2 or more |
| Tightening torque | 4.5N·m (46kgfm) |
| Hole diameter | $\phi 12^{+0.018}$ |

3-6

ZFH

**(Arm type, gantry type, moving arm type 3rd-axis option)
XZ 2nd-axis option**

When using the 3rd-axis model with ZFH for the 3rd-axis, install the workpiece onto the ZFH frame in the following manner.

Four M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the frame's workpiece installation surface. Install the tool using these holes. The tap depth is 9mm.

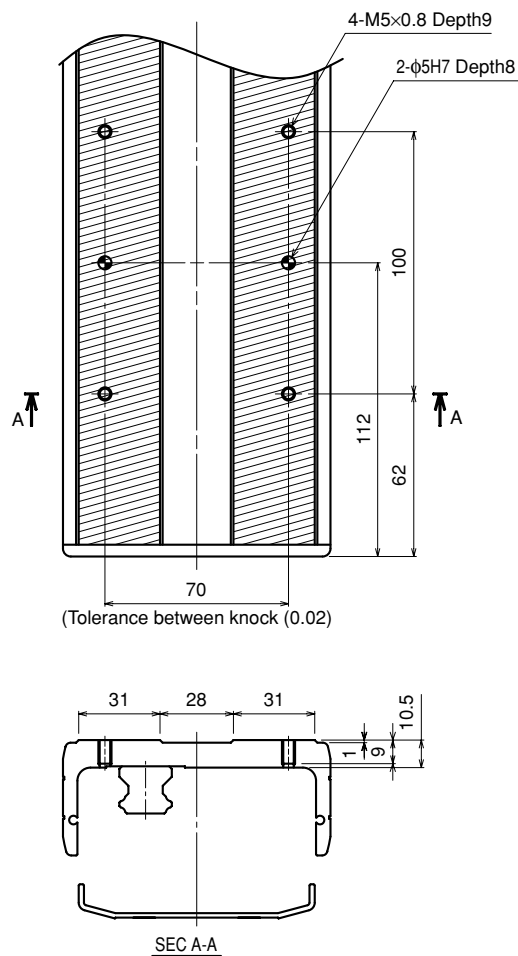


Fig.8-21 Tool installation ZFH

NOTE

There is a step on the ZFH frame.

The actual tool installation surface is the shaded section shown above.

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the screw length exceeds 27mm from the installation surface, the screw could contact the bottom.

3-7

ZFL

(Arm type, moving arm type, 3rd-axis option/XZ type 2-axis model)

When using the 3rd-axis model with ZFL for the 3rd-axis, install the workpiece onto the ZFL slider in the following manner.

Six M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the slider's workpiece installation surface. Install the tool using these holes. Six M5 coarse thread tap holes are opened on the slider side. Use these as required to fix light loads other than the tool, such as the wiring retainer.

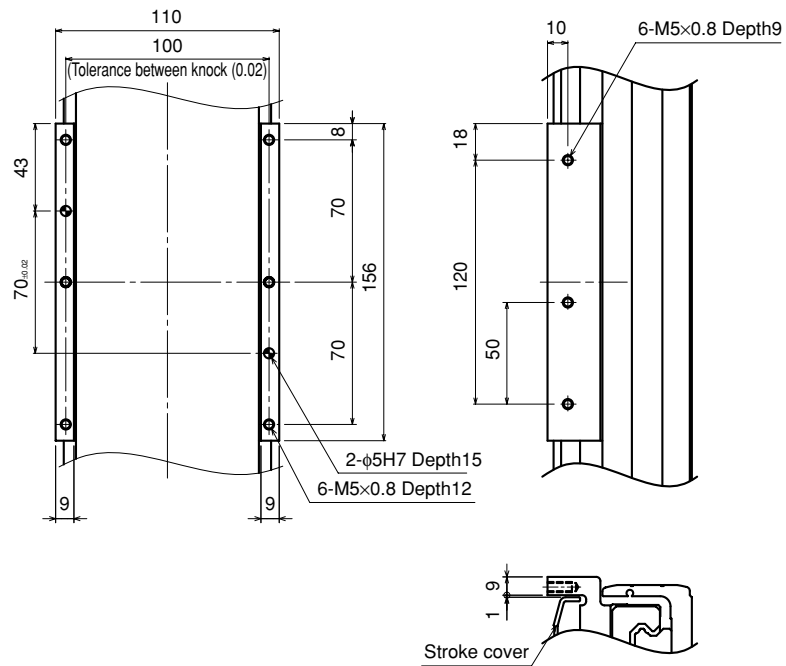


Fig. 8-22 ZFL

Select the maximum nominal length of the tool fixing bolt so that the screw fitting length is 12mm or less.

YAMAHA recommends a screw fitting length of 8mm or more.

CAUTION

If the bolt fitting length is 12mm or more from the installation surface, the bolt will contact the bottom.

4 User Wiring and User Piping

⚠ WARNING

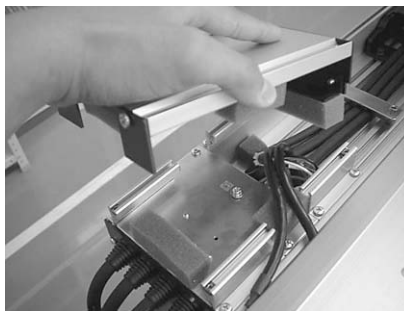
Always turn off the controller before wiring and piping to prevent electrical shocks.

4-1 Cable carrier type

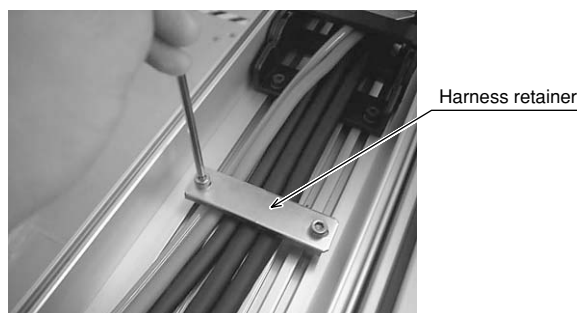
A cable carrier is mounted as a standard between the X and Y axes. When 3rd-axis are used, a cable carrier is also provided between the Y and Z axes, and when using 4th-axis, a cable carrier is also provided between the Z and R axes. Lay the wiring and piping to the tool using these ducts. A 0.3sq 10-core flexible cable is wired from the X-axis wiring box to the final axis' wiring box, and can be used freely. (Refer to the "User wiring specifications" at the end of this section for details.) The wiring and piping methods for a 2-axis arm type are explained below as an example.

4-1-1 Example of wiring and piping methods using cable carrier

- 1) Open the X-axis wiring box cover. Refer to section "2-3-1 Arm type with cable carrier" for details on opening the cover.



- 2) Remove the harness retainer located at the cable carrier outlet. (Hexagon socket bolt M5, 2 bolts)



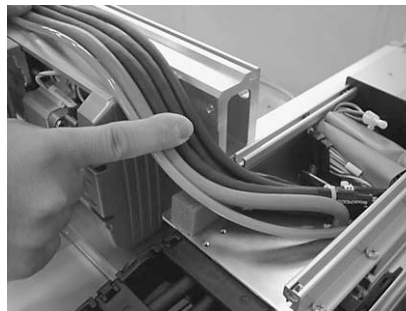
- 3) Pass the cables and air tubes through the cable carrier. The cable carrier has an outer lid that can be opened and closed easily. Use a flat-tip screwdriver to open the lid. Press this lid in to close it. Open and close this lid as necessary.



- 4) Open the Y-axis wiring box cover.



- 5) There is a harness retainer also in the Y-axis box. Remove this, and lay out the wires in the Y-axis box.



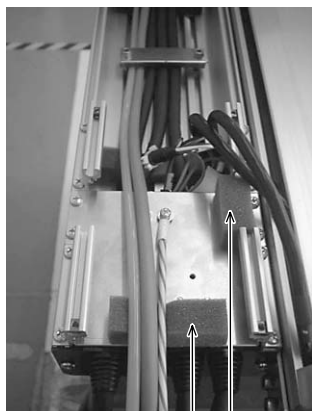
- 6) **CAUTION**
-
1. The wires could be damaged if the harness retainer is tightened too much.
 2. Manually move the robot by the full stroke before fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.
-

After leading all wires, fix the wires with the harness retainer.

7) **CAUTION**

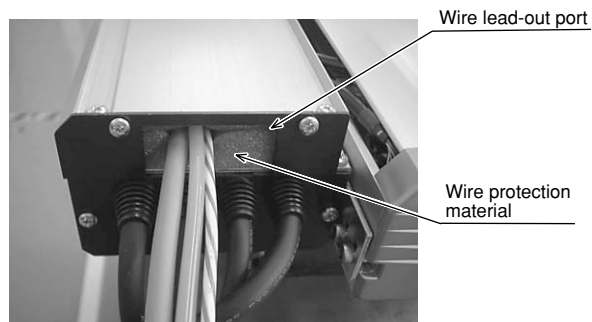
Take care not to catch the harness or air tube with the cover when installing the covers.

Assemble the wiring box cover at the original position.



Lay out the wires on the protection material.

Pass the X-axis wiring through this notch.



Wire lead-out port

Wire protection material

State with cover installed

State of X-axis wiring box when wiring is completed

4-1-2 Cable carrier specifications

CAUTION

When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area.

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

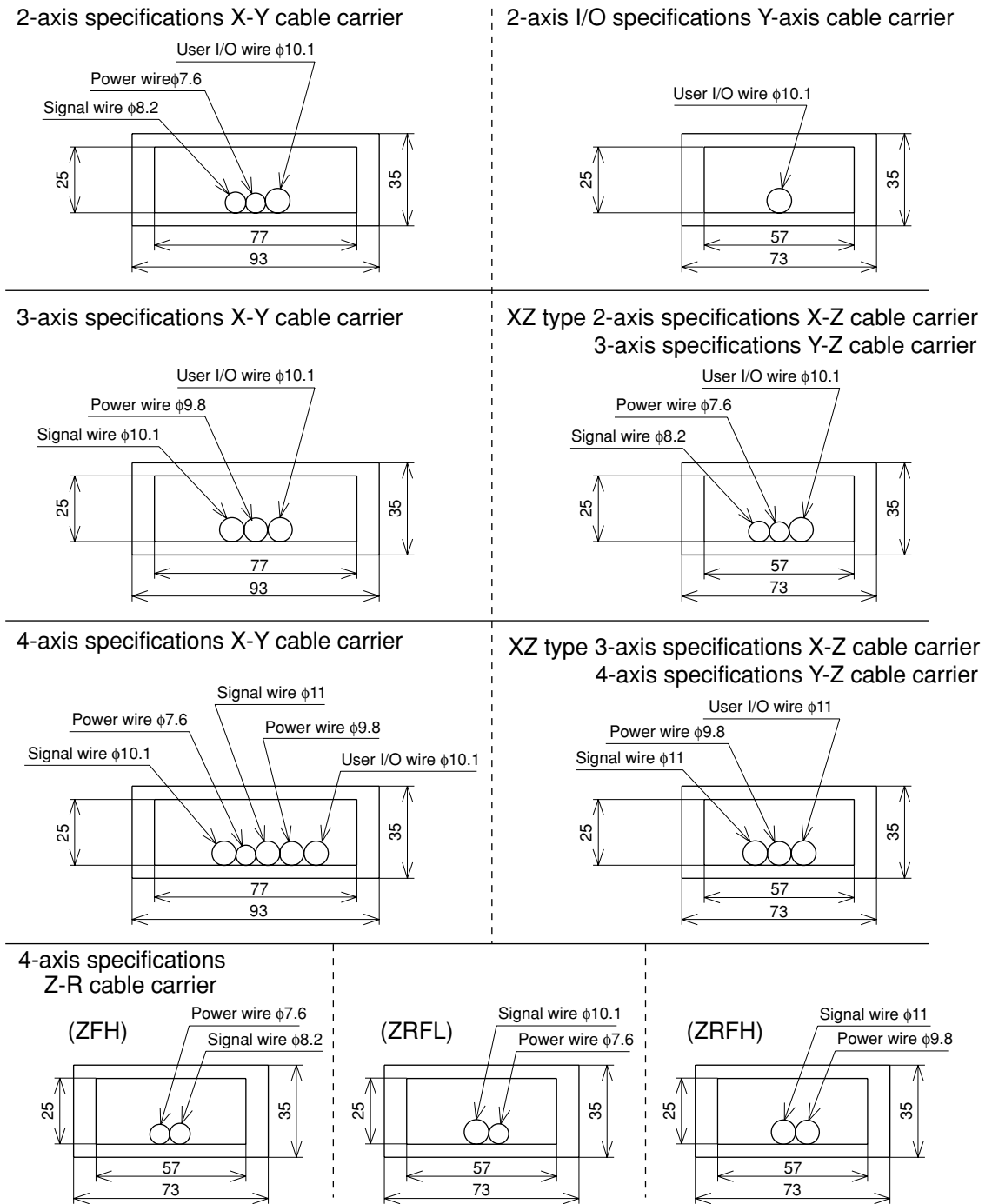


Fig. 8-23

4-1-3 User I/O cable specifications

▲ CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

With the cable carrier model, signal wires ($0.3\text{mm}^2 \times 10$ wires) that can be used freely by the user are laid as a standard between the X-axis wiring box and final axis' wiring box.

Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed. Attach these to the user wiring to eliminate wiring led through the robot.

Crimp the enclosed pins onto the user wiring, and insert into the connector.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

Refer to "1-2. User I/O wiring" in Chapter 5 "Specifications" for details on the wiring specifications.

4-2 Whipover cable type

CAUTION

Do not clamp the wires or tubes to the outside of the independent cable. The independent cable could sag or break and ultimately be disconnected.

The signal wires (0.3mm² × 7 wires) and air tubes (4 × 2.5, 2 tubes) are incorporated in the whipover cable. Use these to wire and pipe to the tool.

| Part No. | Part name | Part No. | Qty. |
|----------|--------------|----------------|------|
| 1 | SM connector | SMR-10V-B | 1 |
| 2 | SM connector | SMP-10V-BC | 1 |
| 3 | Contact | SYM-001T-0.6 | 7 |
| 4 | Contact | SHF-001T-0.8BS | 7 |
| 5 | Cable | | 1 |

| Signal | Connector | NO | NO | Connector | Remarks |
|---------------------|-----------|----|----|-----------|---------|
| General-purpose I/O | ① | 1 | 1 | ② | Brown |
| | | 2 | 2 | | Red |
| | | 3 | 3 | | Orange |
| | | 4 | 4 | | Blue |
| | | 5 | 5 | | Purple |
| | | 6 | 6 | | Gray |
| | | 7 | 7 | | White |
| | | 8 | 8 | | |
| | | 9 | 9 | | |
| | | 10 | 10 | | |

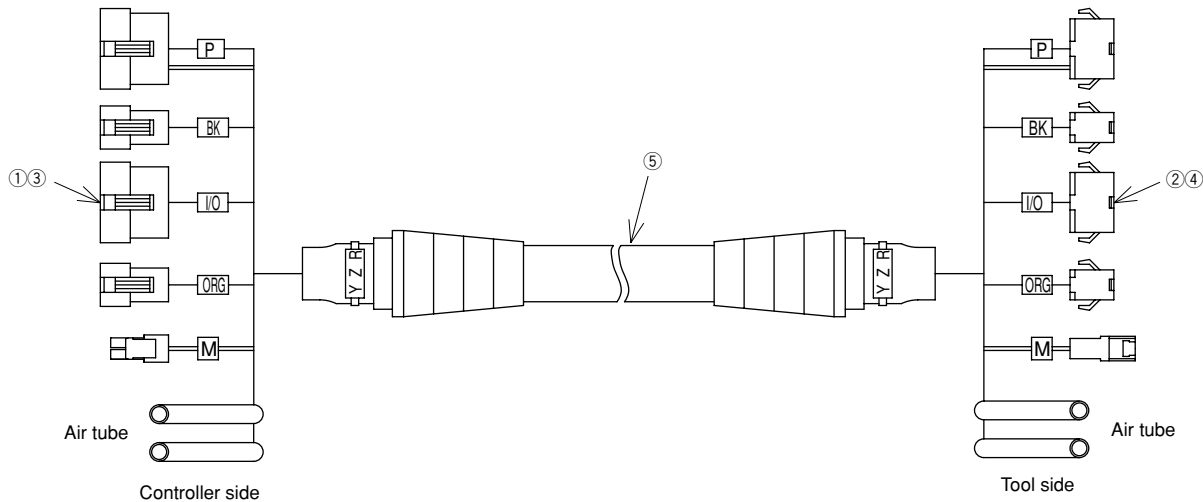


Fig. 8-24 Whipover cable user-wire specifications

4-2-1 Examples of wiring and piping with whipover cable

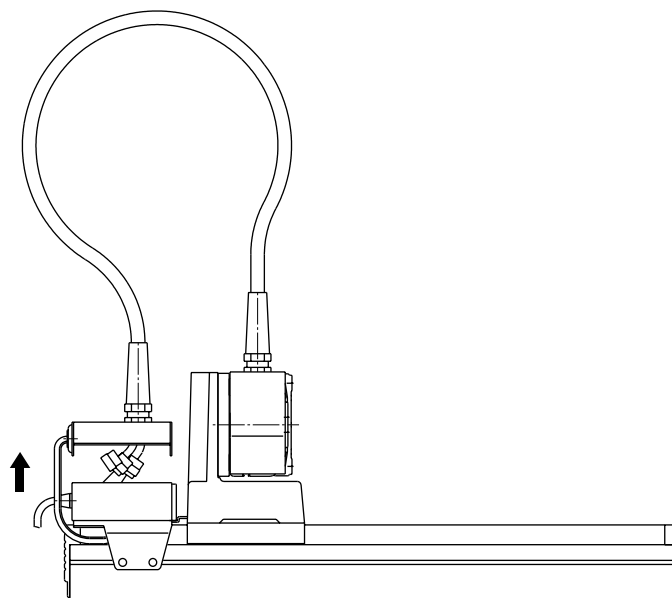
CAUTION

Securely crimp the pin and insert into the pin connector. Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

- 1) Crimp the enclosed connector onto the user cable. Refer to section “1-2. User I/O wire” in Chapter 5 “Specifications” for details on the enclosed connector and pin specifications.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

- 2) When using an air tube, prepare an air coupler for connecting the user air tube with the YAMAHA air tube.
- 3) Open the X-axis wiring box cover.

**Fig. 8-25**

- 4) Place the required cables and air tubes, etc., in the X-axis wiring box. Crimp the enclosed connectors onto the cable beforehand.
- 5) Connect the connectors, and connect the air tubes with the air couplers.
- 6) Open the Y-axis wiring box cover.
- 7) Open holes (or notches) in the rubber grommets attached to the cover, and set the required cables and air tubes, etc., in the Y-axis wiring box. Crimp the enclosed connectors onto the user cables beforehand.
- 8) Connect the connectors in the same manner as the X-axis, and connect the air tubes with the air couplers.
- 9) **CAUTION** _____
Take care not to catch the wiring or air couplers when installing the covers.

When completed with all wiring work, return each wiring box cover to the original positions. Sandwich the X-axis wiring and air tube with the protective material at the wire lead-out port of each wiring box.

5 Periodic inspections

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts, turn OFF the controller, wait for a while and check that the part has cooled.

5-1 Replenishing grease to the linear guide

Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.

NOTE

When the ZF unit is attached for the 3rd-axis, the replenishment work can be carried out easier by moving the Z-axis slider to near the motor (near the origin) and turning the controller power OFF.

- 2) Place a sign indicating “Work In Progress” so that other operators do not turn the controller power ON.
- 3) Remove the axis stroke cover when replenishing grease. (Refer to section "1. Installation" for details on removing the X-axis cover.)

- 4) Using a grease gun, replenish grease from the grease nipple installed on the linear guide bearings.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the linear guide bearings and rail.

X-axis, Y-axis

The X-axis and Y-axis each have four linear guide bearings. Replenish grease to all four bearings.

Wipe off any excessive grease that has seeped out to the rail.

Z-axis (ZF)

One linear guide bearing is attached. A grease nipple is attached to the counter-motor side of the slider, so move the slider to the motor side and then start the work.

- 5) Install the stroke cover.
- 6) Confirm the surrounding safety, and then turn the controller power ON.

5-2 Replenishing grease to the ball screw

The X-axis, Y-axis and Z-axis use a ball screw. Grease must be replenished to this ball screw periodically. Refer to section 5-3-1. for details on replenishing the grease to the ZS/ZRS unit ball screw. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

▲ CAUTION

Always remove the grease nipple after completing the work. Damage or positional deviation could occur if the robot is operated with the grease nipple installed.

- 1) Prepare the following recommended grease nipple beforehand.
Recommended grease nipple A-M6X1 type (JIS B1575)

- 2) Turn the controller power OFF.

NOTE

When the ZF unit is attached for the 3rd-axis, the replenishment work can be carried out easier by moving the Z-axis slider to near the motor (near the origin) and turning the controller power OFF.

- 3) Place a sign indicating “Work In Progress” so that other operators do not turn the controller power ON.
- 4) Remove the stroke cover of the axis to which grease is to be replenished. (Refer to section "1. Installation" for details on removing the X-axis cover.)
- 5) Install the grease nipple onto the ball screw flange.
- 6) Using a grease gun, replenish grease from the grease nipple.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the ball screw nut and screw.

Wipe off any excessive grease.

- Recommended grease : Alvania No. 2 (Showa Shell)
: Daphne Eponex No. 2 (Idemitsu)
- Recommended grease gun : MG70 (THK N-type nozzle)

- 7) Remove the grease nipple.

5-3 Periodic inspection of the ZS/ZRS unit

5-3-1 Replenishing grease to the Z-axis ball screw and ball spline

A ball screw drive is used for the ZS and ZRS vertical axis. Grease must be replenished to this ball screw periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the screws (M4, 6 screws) fixing the cover, and pull the cover upward and off.

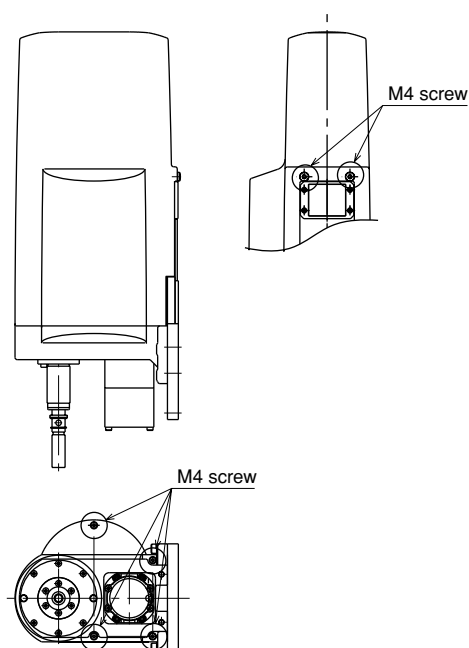


Fig. 8-26 ZS

- 4) Wipe off any excessive grease adhered on the ball screw shaft and ball spline shaft.
- 5) Apply a thin coat of grease on the screw shaft with a finger.
- 6) Return the cover to the original position.

5-3-2 Adjusting the R-axis belt tension (ZRS)

With the ZRS model, a timing belt is used for the R-axis.

If the timing belt tension is weak, adjust the belt tension with the following procedures.

⚠ WARNING

There is a risk of injury if fingers, etc., are caught between the drive section pulley and belt section. Always turn the controller power OFF and carefully carry out the work if these parts may be contacted.

⚠ CAUTION

The position will deviate when the belt tension is adjusted. Carry out absolute reset, and reset the basic coordinates and point data.

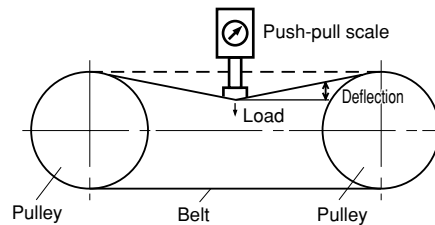


Fig. 8-27 Adjusting the belt tension

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the cover. (M4, 6 screws)
- 4) The following work must be carried out by two operators. One operator must apply a vertical load on the center of the belt with the push-pull scale, and the other operator must measure the belt deflection at that time.
- 5) If the measured value is within the range shown below, there is no need for adjustment. Adjust with the following procedure if the measured value is not within the range.

Table 8-1

| | |
|-------------------|---------------------------------|
| Load | 4.4 to 4.8N (0.45 to 0.49kgf) |
| Deflection amount | 2mm |

- 6) Loosen the M4 bolt ① (three positions) shown in Fig. 8-28.

- 7) If the value measured in step 4) is smaller than the value given in Table 8-1, move the R-axis motor so that the tension increases. If larger than the value in Table 8-1, move the R-axis motor so that the tension decreases. Then, fix the bolts.
- 8) Measure the belt tension again with the procedure given in step 4).

If the measured value is within the range shown in Table 8-1, adjustment of the R-axis belt tension is completed. If the measured value is not within the range shown in Table 8-1, repeat steps 6) to 8) and adjust.

- 9) Tighten the M4 bolt ① with the specified tightening torque.
Specified torque $4.5\text{N}\cdot\text{m}$ (46kgf·cm)
- 10) Return the cover to the original position.

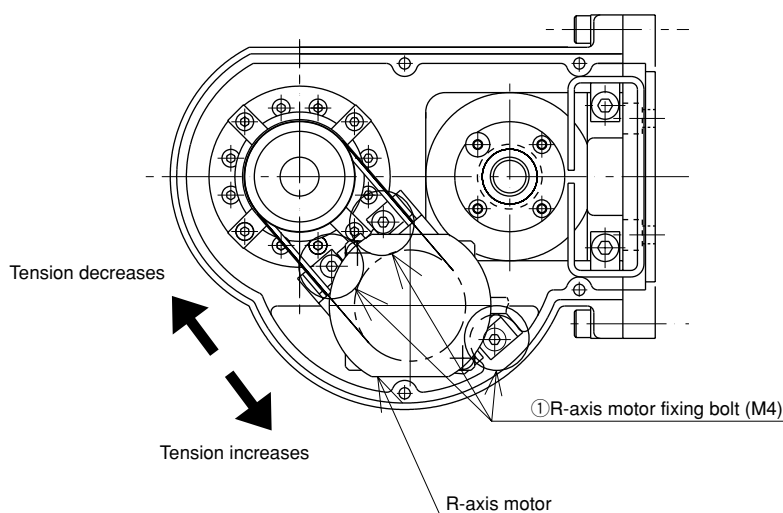


Fig. 8-28 ZRS belt tension

5-3-3 Replacing the R-axis harmonic drive (ZRS)

The ZRS R-axis speed reduction gear uses a harmonic drive.

The ZRS uses a harmonic drive as the R-axis speed reduction gear, which must be replaced after using for a set period. Determine the harmonic drive replacement period with the following procedure, and replace as required.

The ZRS harmonic grease uses a long-life type, and the grease does not need to be replaced.

Replacement period

The harmonic drive replacement period is determined by the total number of wave generator rotations. A calculation example is shown below.

The recommended harmonic drive replacement period is 8.4×10^8 rotations (at usage atmospheric temperature range 0°C to $+40^\circ\text{C}$).

The harmonic drive should be replaced earlier if the robot operation duty is high or if the temperature conditions are poor.

$$[\text{Replacement period}] = 8.4 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta) \text{ years}$$

n : Number of robot movements in one minute

θ : Average axis rotation in one movement

N : Deceleration rate (50 for ZRS R-axis)

h : Number of operation hours per day

D : Number of operation days per year

(Example) The YK500X X-axis harmonic drive replacement period when the axis rotates an average quarter turn every movement and the robot moves ten times in one minute. (Operation hours: 24 hours/day, number of operation days: 240 days/year)

n : 10

θ : 0.25

N : 50

h : 24

D : 240

$$\begin{aligned} [\text{Replacement period}] &= 8.4 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta) \\ &= 8.4 \times 10^8 / (10 \times 60 \times 24 \times 240 \times 50 \times 0.25) \\ &= 19.4 \text{ years} \end{aligned}$$

Consult with YAMAHA when actually replacing the harmonic drive.

CHAPTER 9

MXYY

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MEMO

1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

Install the MXYX by tapping holes into the installation base and securing the robot to the base with M8 bolts from the inside of the robot.

1-1 Installation bolt types

- Use the following type of installation bolt.
Hexagon socket head cap screw M8 Strength 8.8T

1-2 Installation bolt nominal length

⚠ CAUTION

Do not use washers or spring washers with the tightening bolt.
The bolt head could interfere with the linear guide's bearings and be damaged.

If the installation base is made of steel, secure 1D or more (8mm or more for M8) for the screw fitting length. When made of aluminum, secure 1.5D or more (12mm or more for M8).

The frame thickness is 26.5mm. (Refer to Fig. 9-1.)

Recommended nominal length

| | |
|--|--------------|
| When installation base is made of steel | 35mm or more |
| When installation base is made of aluminum | 40mm or more |

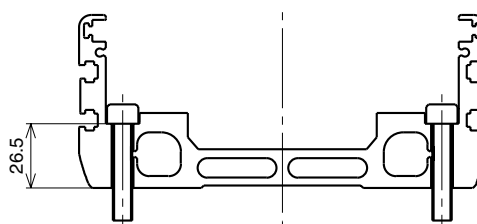


Fig. 9-1

1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

Recommended torque 22.5N·m to 36.3N·m (230kgf·cm to 370kgf·cm)

1-4

**Installation methods
(Arm type, moving arm type, pole type, gantry type X-axis)**

⚠ WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

- 1) Tap M8 coarse screw thread holes into the installation base where the robot is to be installed.
Refer to the XY-X Series catalog for the hole positions.
- 2) Loosen the small screws (M5, 4 screws) fixing the X-axis wiring box. The wiring box can be slid along the T slot when these screws are loosened. (Refer to Fig. 9-2.)

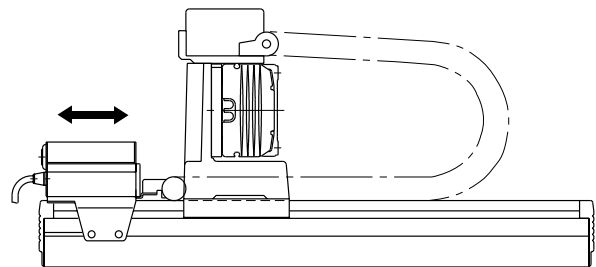


Fig. 9-2

- 3) Remove the countersunk head screws fixing the X-axis stroke cover. (M4 countersunk head screw, 6 screws)

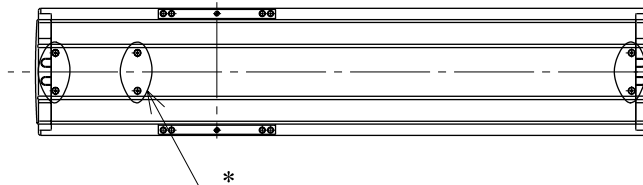


Fig. 9-3 MXY X-axis

⚠ CAUTION

The screws indicated with an asterisk (*) in the above drawing should be removed from the wiring clearance after sliding the X-axis wiring box. Take care not to damage the wires at this time. (Refer to Fig. 9-4.)

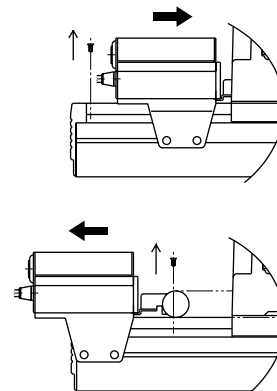


Fig. 9-4

- 4) Remove the stroke cover.



If the cover is difficult to remove, manually move the Y-axis to the motor side stroke end. The cover will be easier to remove.

If the X-axis stroke is 550mm or less, remove the X-axis wiring box before removing the stroke cover.

- 5) Fix the robot onto the installation base with the designated bolts.



- 6) After installing, return the stroke cover and X-axis wiring box to the original positions.

CAUTION

Always install the X-axis wiring box at the original position. The amount of projection from the cable carrier's stroke end could change, or the cable carrier and Y-axis bracket could contact. (Refer to Fig. 9-5.)

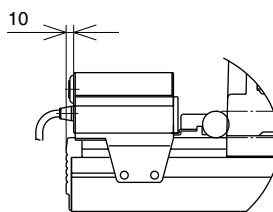


Fig. 9-5 MXY box position

1-5 Installation methods (Gantry type support axis)

The MXYX and HXYX gantry types have a guide rail for support on the Y-axis end so that heavy loads can be handled. When installing, take care to the parallelism of the X-axis and guide rail and to the difference in height from the installation surface.

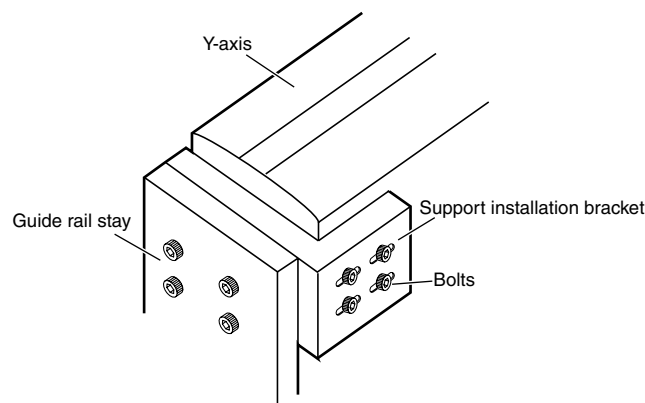
If the distance between the X-axis and guide rail is within $\pm 5\text{mm}$, it can be changed or adjusted. The procedures are given below.

CAUTION

Move the X-axis as much as possible, and tighten the bolts where the movement is the lightest.

Set the X-axis and guide rail parallelism during installation. Make sure that there is no difference in the height direction of the X-axis and guide rail installation surface.

- 1) **Fix the robot onto the specified position of the installation base with bolts.**
Do not tighten the guide rail bolt at this time. Securely fix the X-axis section onto the installation base.
- 2) **When the ZR-axis is provided, or if tools are already attached, move as close to the X-axis side as possible so that a load is not applied on the guide rail.**
- 3) **Loosen the bolt for the Y-axis and support installation bracket. (Refer to following drawing.)**
- 4) **Temporarily fix the guide rail onto the installation base with bolts.**
The parallelism of the guide rail and X-axis must be set using a dial gauge or pick gauge, etc.
- 5) **To easily set the parallelism, first tighten the bolt loosened in step 3).**
Set the X-axis near one end, and tighten the bolt on the guide rail end in this state. Next, move the X-axis to the opposite end, and tighten the bolt on the opposite side of the guide rail in this state. Repeat this until all bolts have been tightened.



Adjustment of gantry type support rail

2 Protective Connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground tap with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground terminal is located on the inside of the X-axis wiring box.

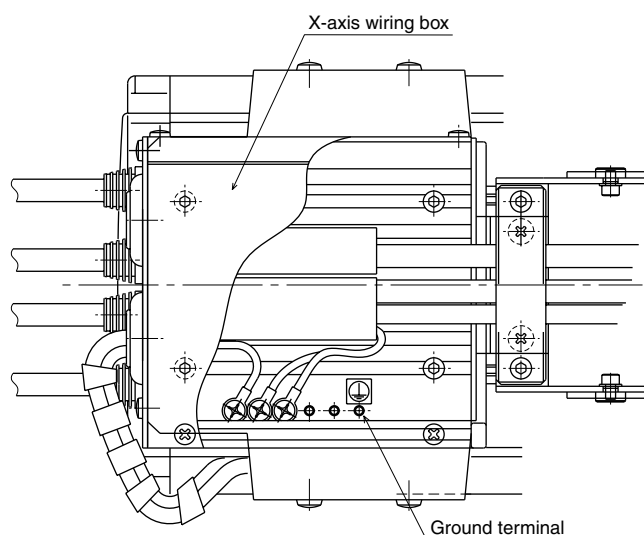


Fig. 9-6

2-2 Ground wire

Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

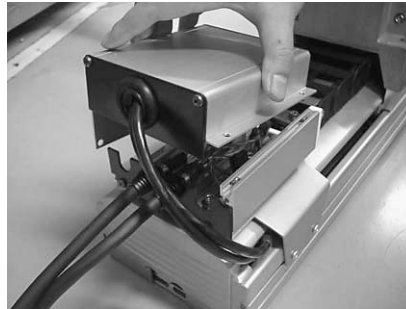
2-3 Wiring methods

CAUTION

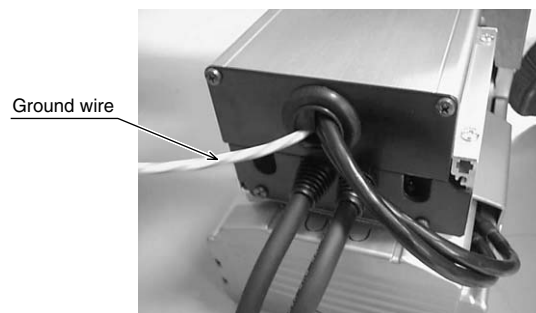
Be sure to insert the lock washer between the ring-tongue terminal and robot in step3 below.

Proper continuity may not be secured if the lock washer is dislocated.

- 1) Loosen the four M4 small screws, and open the X-axis wiring box cover.



- 2) Open holes (or notches) in the grommets on the end face of the X-axis wiring box, and pass the ground wire through.



- 3) Connect the ring-tongue terminal of the ground wire to the ground terminal on the robot.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 8-9.)

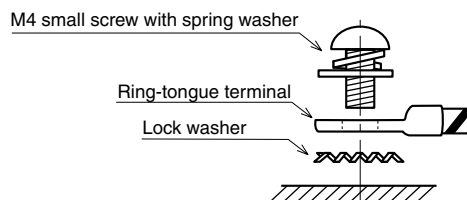


Fig. 9-7

- 4) Return the X-axis wiring box cover to the original position.

3 Installing the Tool

Install the user tool onto the robot's tool installation surface in the following manner.

⚠ WARNING

Always turn the controller power OFF before installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

3-1 Arm type, pole type 2-axis model

Eight M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider installation surface. (Refer to Fig. 9-8 and Fig. 9-9.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

⚠ CAUTION

If the fitting length is less than 6mm, the threads could be damaged during tightening. Note that if the fitting length exceeds 8mm, the bolt end could contact the cover.

NOTE

There is a step on the top of the slider. The actual tool installation surface is the shaded section shown above.

Select the nominal length of the tool fixing bolt so that the fitting length of the screw fixing the tool is 6mm or more, 8mm or less. (Refer to the cross-section drawings in Fig. 9-8 and Fig. 9-9.)

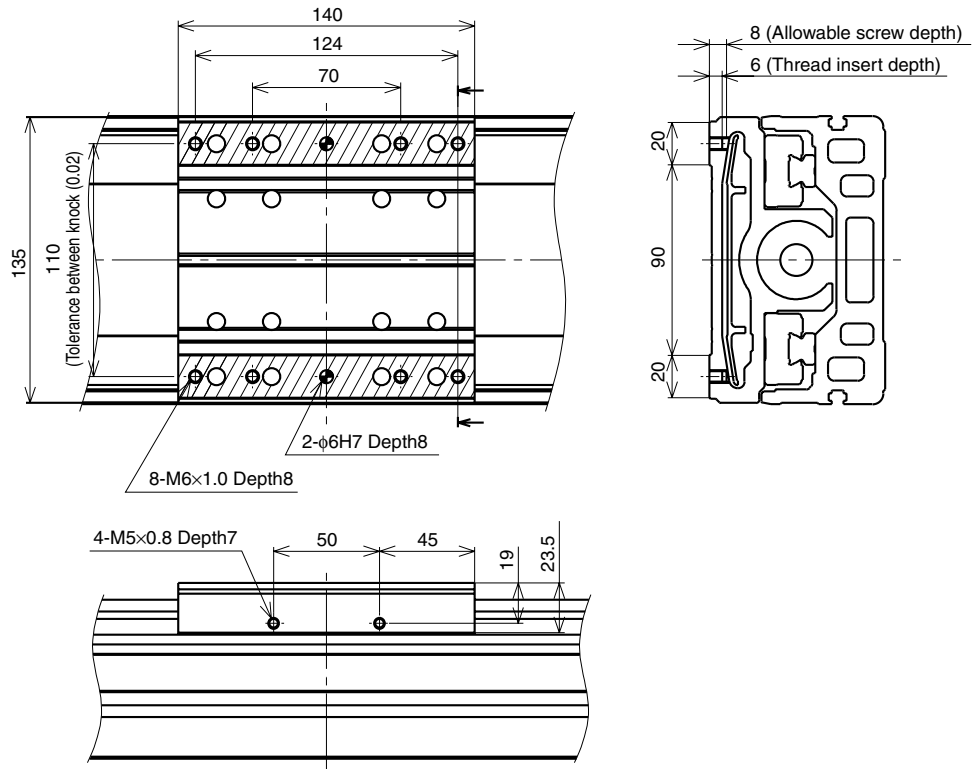


Fig. 9-8 Arm type, gantry type

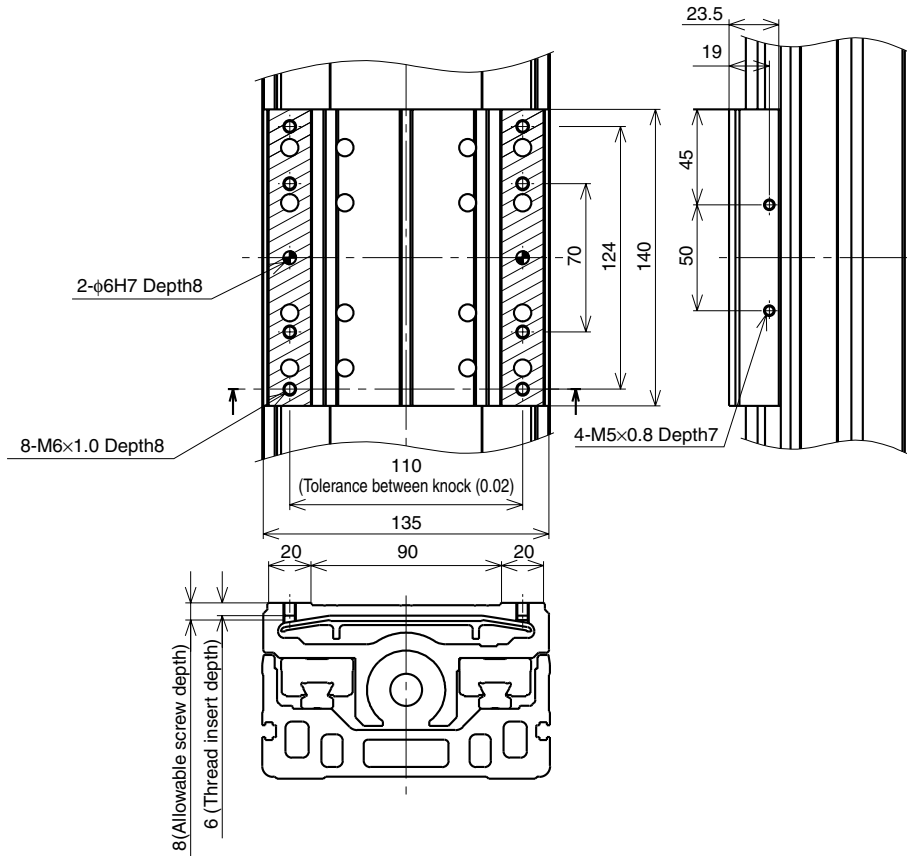


Fig. 9-9 MXYX pole type

3-2 Moving arm type 2-axis model

For the moving arm type, an aluminum bracket is attached to the end of the Y-axis. Install the tool on this bracket.

Twelve M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the bracket.

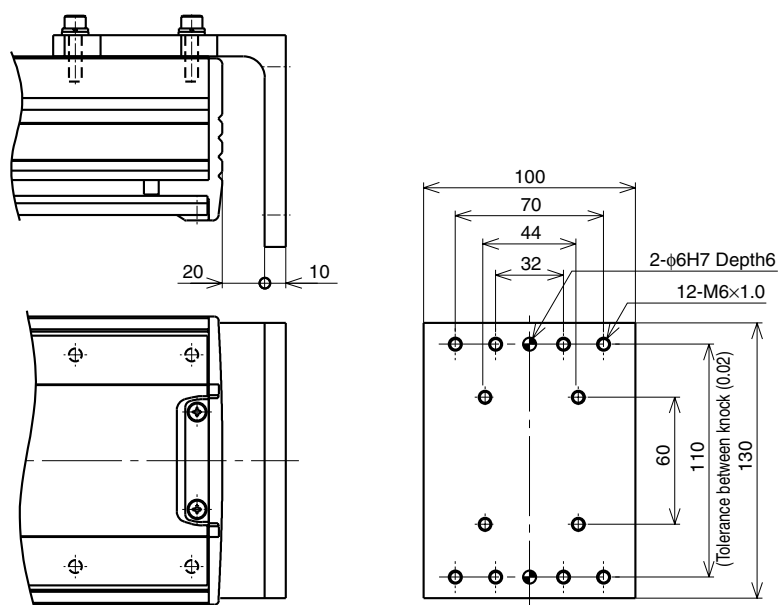


Fig. 9-10 Moving arm type

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the length of the bolt screw is 30mm or more from the installation surface, the screw could contact the Y-axis.

Select the minimum fixing bolt screw length so that the screw fitting length is 9mm or more.

3-3

ZF (Arm type, moving arm type, gantry type 3rd-axis option)

When using the 3rd-axis model with ZF for the 3rd-axis, install the workpiece onto the ZF slider in the following manner.

Four M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the slider's workpiece installation surface. Install the tool using these holes. Four M5 coarse thread tap holes are opened on the slider side. Use these as required to fix light loads other than the tool, such as the wiring retainer.

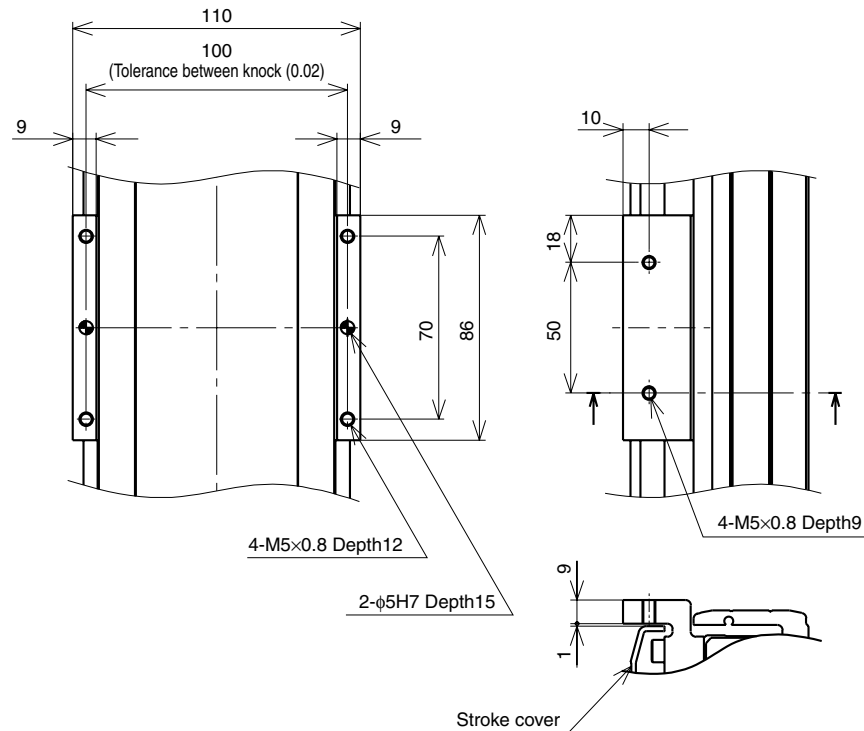


Fig. 9-11 ZF

CAUTION

If the bolt fitting length is 12mm or more from the installation surface, the bolt will contact the bottom.

Select the maximum nominal length of the tool fixing bolt so that the screw fitting length is 12mm or less.

YAMAHA recommends a screw fitting length of 8mm or more.

3-4

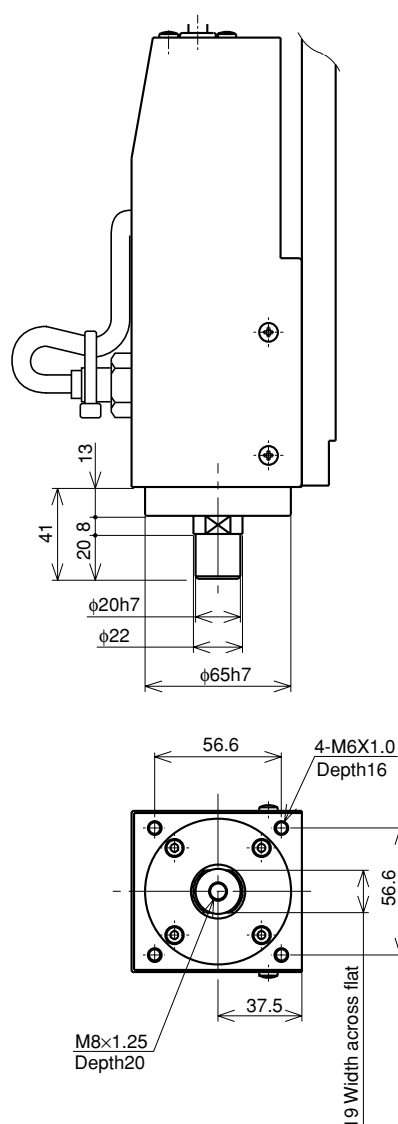
RF**(Arm type, moving arm type, 4th-axis option/XZ type 3rd-axis option)****CAUTION**

Use the tap hole on the end face of the shaft only to prevent the tool from dislocating.

Do not use only this hole to install the tool. The tool could dislocate and fly off the installation section during robot operation.

When using the 4th-axis model with RF (rotary axis unit) for the 4th-axis, install the tool onto the RF shaft in the following manner.

Use the $\phi 20$ section on the shaft, and fix the tool with a bolt coupling or split clamp.

**Fig. 9-12 RF**

3-5

ZFH

(Arm type, gantry type, moving arm type 3rd-axis option)
XZ 2nd-axis option

When using the 3rd-axis model with ZFH for the 3rd-axis, install the workpiece onto the ZFH frame in the following manner.

Four M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the frame's workpiece installation surface. Install the tool using these holes. The tap depth is 9mm.

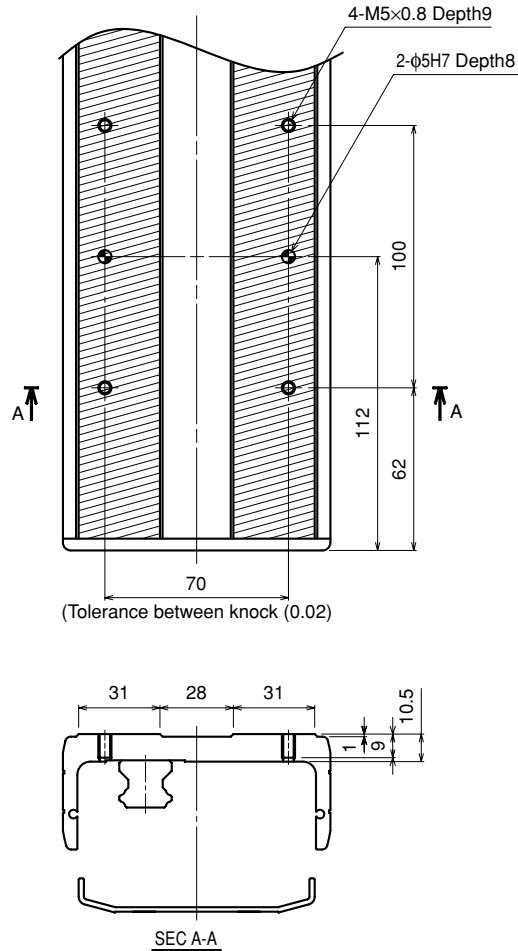


Fig. 9-13 Tool installation ZFH

NOTE

There is a step on the ZFH frame.
The actual tool installation surface is the shaded section shown above.

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the screw length exceeds 27mm from the installation surface, the screw could contact the bottom.

3-6

ZFL**(Arm type, moving arm type, 3rd-axis option/XZ type 2-axis model)**

When using the 3rd-axis model with ZFL for the 3rd-axis, install the workpiece onto the ZFL slider in the following manner.

Six M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the slider's workpiece installation surface. Install the tool using these holes. Six M5 coarse thread holes are opened on the slider side. Use these as required to fix light loads other than the tool, such as the wiring retainer.

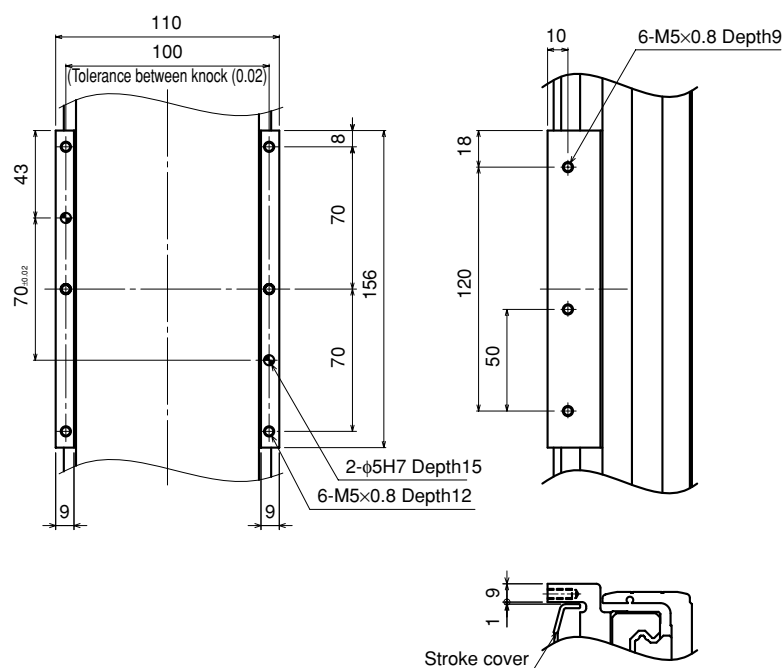


Fig. 9-14 ZFL

Select the maximum nominal length of the tool fixing bolt so that the screw fitting length is 12mm or less.

YAMAHA recommends a screw fitting length of 8mm or more.

CAUTION

If the bolt fitting length is 12mm or more from the installation surface, the bolt will contact the bottom.

4 User Wiring and User Piping

⚠ WARNING

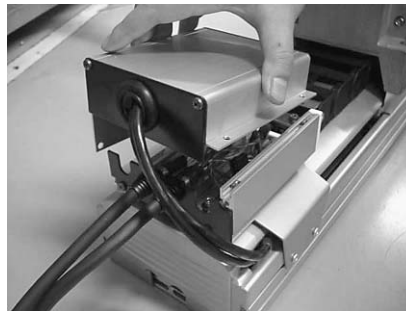
Always turn off the controller before wiring and piping to prevent electrical shocks.

4-1 Cable carrier type

A cable carrier is mounted as a standard between the X and Y axes. When 3rd-axis are used, a cable carrier is also provided between the Y and Z axes, and when using 4th-axis, a cable carrier is also provided between the Z and R axes. Lay the wiring and piping to the tool using these ducts. A 0.3sq 10-core flexible cable is wired from the X-axis wiring box to the final axis' wiring box, and can be used freely. The wiring and piping methods for a 2-axis arm type are explained below as an example.

4-1-1 Example of wiring and piping methods using cable carrier

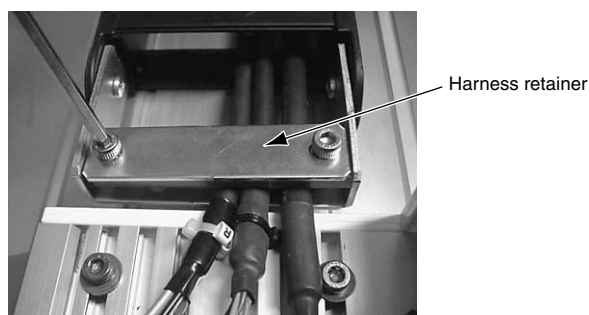
- 1) Remove the four M4 small screws and open the X-axis wiring box cover.



- 2) Rubber grommets are attached to the end face of X-axis wiring box. Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through.



- 3) Remove the harness retainer located at the cable carrier outlet. (Hexagon socket bolt M5, 2 bolts)



- 4) Pass the required wires and pipes through the cable carrier.



The cable carrier has an outer lid that can be opened and closed easily. Use a flat-tip screwdriver to open the lid. Press this lid in to close it.



- 5) Open the Y-axis wiring box cover, and lay the required wiring and piping.

6) **CAUTION**

1. The wires could be damaged if the harness retainer is tightened too much.
2. Manually move the robot by the full stroke before fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.

When completed with the wiring, fix with the harness retainer in the wiring box.

7) **CAUTION**

Take care not to catch the harness or air tube with the cover.

Return each wiring box cover to the original position.

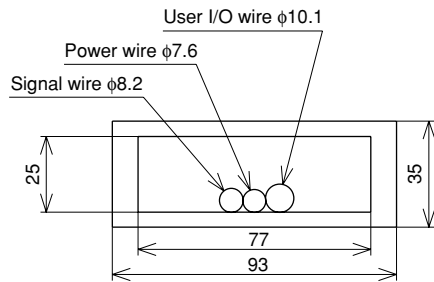
4-1-2 Cable carrier specifications

CAUTION

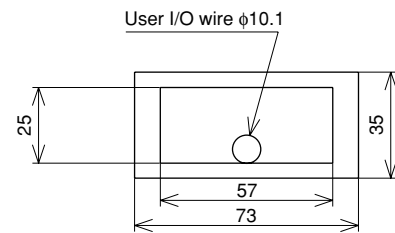
When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area. (This ratio is called the cable carrier space factor.)

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

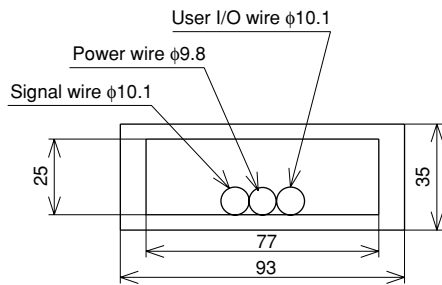
2-axis specifications X-Y cable carrier



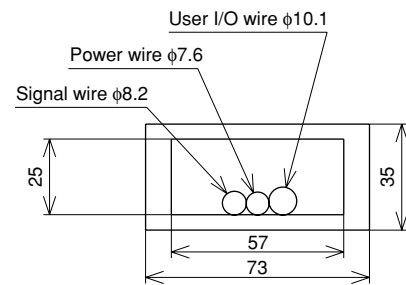
2-axis I/O specifications Y-axis cable carrier



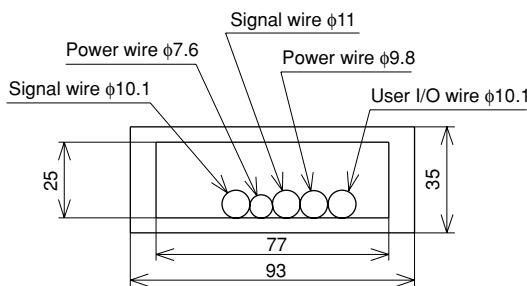
3-axis specifications X-Y cable carrier



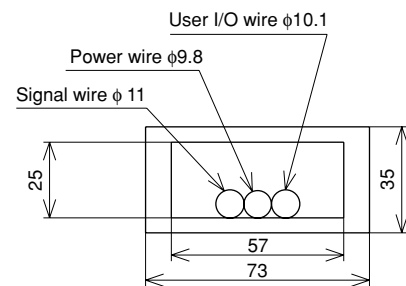
3-axis specifications Y-Z cable carrier



4-axis specifications X-Y cable carrier



4-axis specifications Y-Z cable carrier



XZ type 3-axis specifications Z-R cable carrier
4-axis specifications Z-R cable carrier

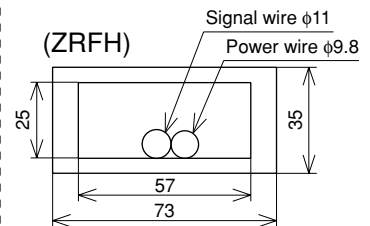
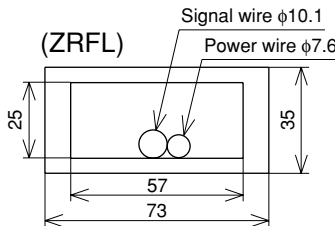
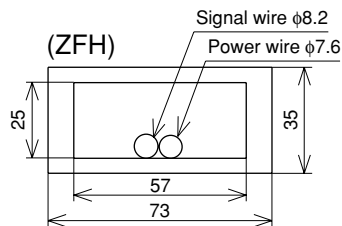


Fig. 9-15

4-1-3 User I/O cable specifications

⚠ CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

With the cable carrier model, signal wires ($0.3\text{mm}^2 \times 10$ wires) that can be used freely by the user are laid as a standard between the X-axis wiring box and final axis' wiring box.

Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed. Attach these to the user wiring to eliminate wiring led through the robot.

Crimp the enclosed pins onto the user wiring, and insert into the connector.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

Refer to "1-2. User I/O wiring" in Chapter 5 "Specifications" for details on the wiring specifications.

4-2 Whipover cable type

CAUTION

Do not clamp the wires or tubes to the outside of the independent cable. The independent cable could sag or break and ultimately be disconnected.

The signal wires (0.3mm² × 7 wires) and air tubes (4 × 2.5, 2 tubes) are incorporated in the Whipover cable. Use these to wire and pipe to the tool.

| Part No. | Part name | Part No. | Qty. |
|----------|--------------|----------------|------|
| 1 | SM connector | SMR-10V-B | 1 |
| 2 | SM connector | SMP-10V-BC | 1 |
| 3 | Contact | SYM-001T-0.6 | 7 |
| 4 | Contact | SHF-001T-0.8BS | 7 |
| 5 | Cable | | 1 |

| Signal | Connector | NO | NO | Connector | Remarks |
|---------------------|-----------|----|----|-----------|---------|
| General-purpose I/O | ① | 1 | 1 | ② | Brown |
| | | 2 | 2 | | Red |
| | | 3 | 3 | | Orange |
| | | 4 | 4 | | Blue |
| | | 5 | 5 | | Purple |
| | | 6 | 6 | | Gray |
| | | 7 | 7 | | White |
| | 8 | 8 | | | |
| | 9 | 9 | | | |
| | 10 | 10 | | | |

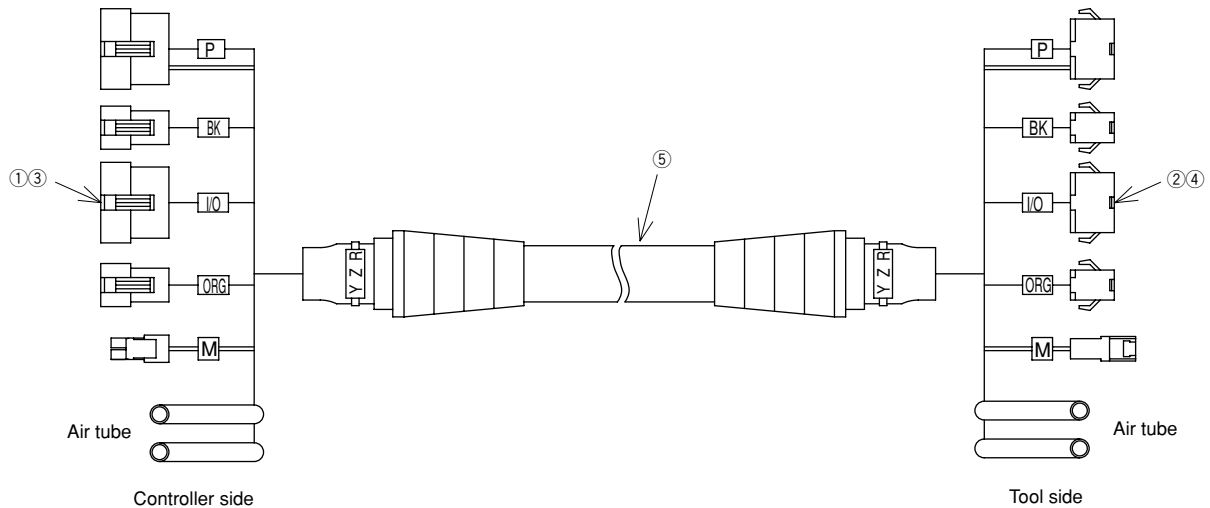


Fig. 9-16 Whipover cable user-wire specifications

4-2-1 Examples of wiring and piping with Whipover cable

CAUTION

Securely crimp the pin and insert into the pin connector. Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

- 1) Crimp the user's cable and tool wiring onto the enclosed connector. Refer to section "1-2. User I/O wire" in Chapter 5 "Specifications" for details on the enclosed connector and pin specifications.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

- 2) When using an air tube, prepare an air coupler for connecting the user air tube with the YAMAHA air tube.
- 3) Open the X-axis wiring box cover.

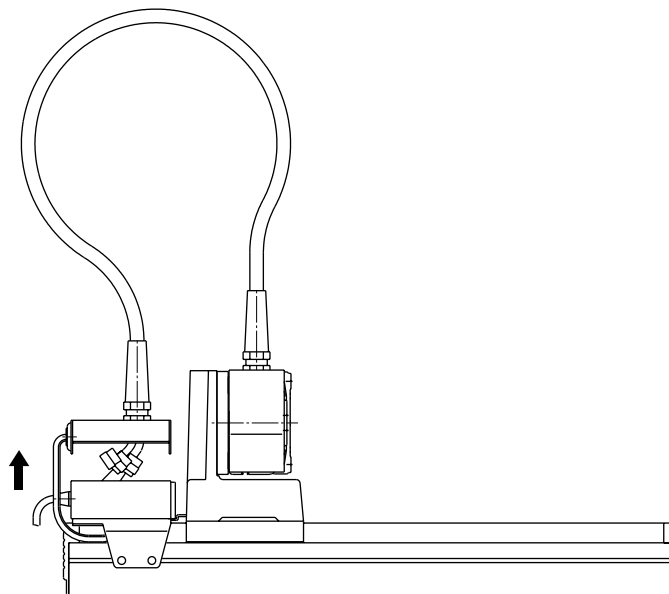


Fig. 9-17

- 4) Rubber grommets are attached to the X-axis wiring box. Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through. Crimp the enclosed connectors onto the cables.
- 5) Connect the connectors, and connect the air tubes using the air couplers.
- 6) Open the Y-axis wiring box cover.
- 7) Rubber grommets are also attached to the Y-axis wiring box. Open holes in these grommets, and pass the tool side cables and air tubes through.
- 8) Connect the connectors in the same manner as the X-axis, and connect the air tubes with the air couplers.

CAUTION

Take care not to catch the wiring or air couplers when installing the covers.

- 9) When completed with all wiring work, return each wiring box cover to the original positions. Sandwich the X-axis wiring and air tube with the protective material at the wire lead-out port of each wiring box.

5 Periodic Inspections

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts, turn OFF the controller, wait for a while and check that the part has cooled.

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

5-1 Replenishing grease to the linear guide

Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.

NOTE

When the ZF unit is attached for the 3rd-axis, the replenishment work can be carried out easier by moving the Z-axis slider to near the motor (near the origin) and turning the controller power OFF.

- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the axis stroke cover when replenishing grease.

- 4) Using a grease gun, replenish grease from the grease nipple installed on the linear guide bearings.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the linear guide bearings and rail.

The X-axis and Y-axis each have four linear guide bearings. Replenish grease to all four bearings.

Wipe off any excessive grease that has seeped out to the rail.

Recommended grease gun : MG70 (THK H-type nozzle)

- 5) Return the stroke cover to the original position.

5-2 Replenishing grease to the ball screw

The X-axis, Y-axis and Z-axis use a ball screw. Grease must be replenished to this ball screw periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

CAUTION

Always remove the grease nipple after completing the work. Damage or positional deviation could occur if the robot is operated with the grease nipple installed.

- 1) Prepare the following recommended grease nipple beforehand.
Recommended grease nipple A-M6X1 type (JIS B1575)

- 2) Turn the controller power OFF.

NOTE

When the ZF unit is attached for the 3rd-axis, the replenishment work can be carried out easier by moving the Z-axis slider to near the motor (near the origin) and turning the controller power OFF.

- 3) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 4) Remove the stroke cover of the axis to which grease is to be replenished.
- 5) Install the grease nipple on the M6 tap on the ball screw flange surface.
- 6) Using a grease gun, replenish grease from the grease nipple.



Sufficient grease has been replenished when new grease starts to seep out to the screw shaft.

Wipe off any excessive grease.

Recommended grease gun : MG70 (THK H-type nozzle)

- 7) Remove the grease nipple.
- 8) Return the stroke cover to the original position.

CHAPTER 10

HXYX

| | | |
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1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

Install the HXYX by tapping holes into the installation base and securing the robot to the base with M8 bolts from the inside of the robot. The installation method is the same for the arm type, pole type, moving arm type and gantry type X-axis. Note that the installation method differs for the XZ type and gantry type support axis.

1-1 Installation method 1 (Arm type, moving arm type, pole type, gantry type X-axis)

Install the arm type, moving arm type, pole type and gantry type X-axis in the following manner.

1-1-1 Installation bolt types

- Use the following type of installation bolt.
Hexagon socket head cap screw M8 Strength 8.8T

1-1-2 Installation bolt nominal length

⚠ WARNING

Do not use washers or spring washers with the tightening bolt. The bolt head could interfere with the linear guide's bearings and be damaged.

If the installation base is made of steel, secure 1D or more (8mm or more for M8) for the screw fitting length. When made of aluminum, secure 1.5D or more (12mm or more for M8).

The frame thickness is 33mm. (Refer to Fig. 10-1.)

Recommended nominal length 45mm or more

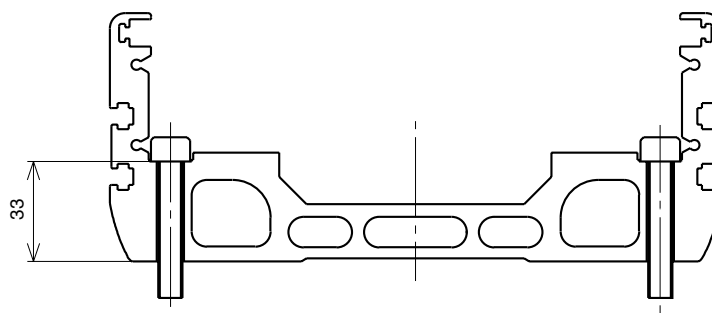


Fig. 10-1

1-1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

Recommended torque 22.5N·m to 36.3N·m (230kgf·cm to 370kgf·cm)

1-1-4 Installation methods

⚠ WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

- 1) Tap M8 coarses screw thread holes into the installation base where the robot is to be installed.
Refer to the XY-X Series catalog for the hole positions.
- 2) Loosen the small screws (M5, 4 screws) fixing the X-axis wiring box. The wiring box can be slid along the T slot when these screws are loosened.

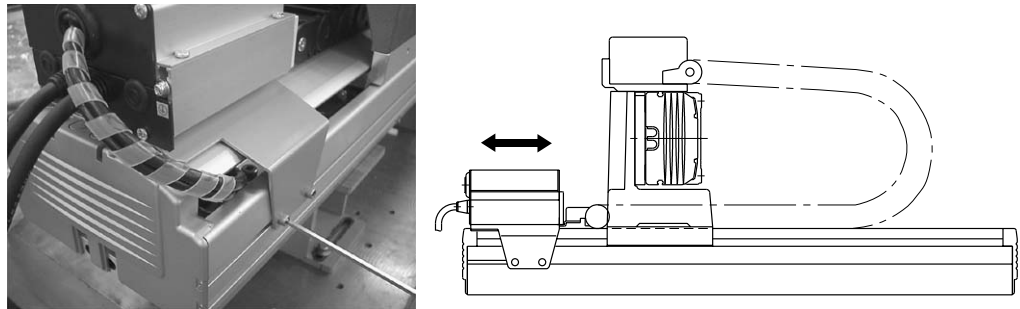


Fig. 10-2

- 3) Remove the countersunk head screws fixing the X-axis stroke cover. (M4 countersunk head screw, 6 screws)

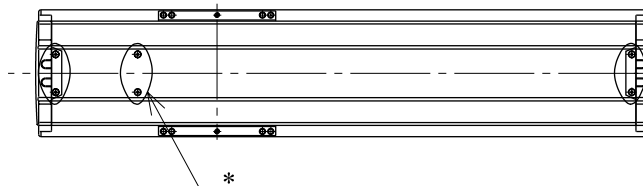


Fig. 10-3

⚠ CAUTION

The screws indicated with an asterisk (*) in the above drawing should be removed from the wiring clearance after sliding the X-axis wiring box. Take care not to damage the wires at this time. (Refer to Fig 10-4.)

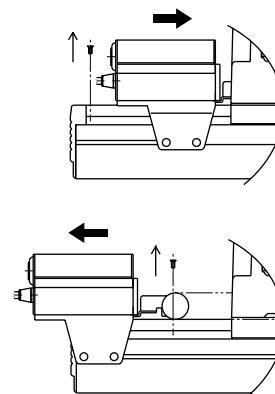
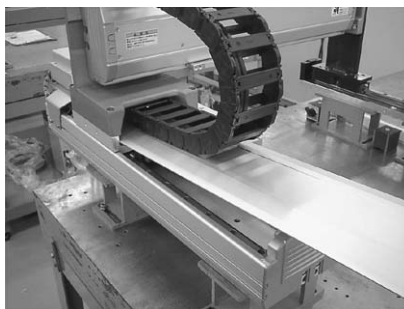


Fig. 10-4

CAUTION

Decorative plates are attached to both ends of the stroke cover. Take care not to lose these plates.

- 4) Remove the stroke cover.



If the cover is difficult to remove, manually move the Y-axis to the motor side stroke end. The cover will be easier to remove.

- 5) Fix the robot onto the installation base with the designated bolts.



- 6) After installing, return the stroke cover and X-axis wiring box to the original positions.

⚠ CAUTION

Always install the X-axis wiring box at the original position. The amount of projection from the cable carrier's stroke end could change, or the cable carrier and Y-axis bracket could contact.

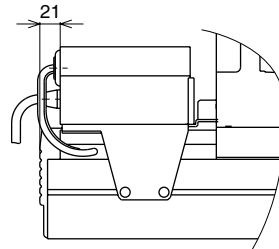


Fig. 10-5 MXY box position

1-2 Installation method 2 (XZ type)

Install the XZ type in the following manner.

1-2-1 Installation bolt

- Use the following type of installation bolt.
Hexagon socket bolt M8 Strength 8.8T

1-2-2 Installation bolt nominal length

⚠ WARNING

Do not use washers or spring washers with the tightening bolt. The bolt head could interfere with the linear guide's bearings and be damaged.

If the installation base is made of steel, secure 1D or more (8mm or more for M8) for the screw fitting length. When made of aluminum, secure 1.5D or more (12mm or more for M8).

The frame thickness is 26.5mm. (Refer to Fig. 10-6.)

Recommended nominal length

When installation base is made of steel 35mm or more

When installation base is made of aluminum 40mm or more

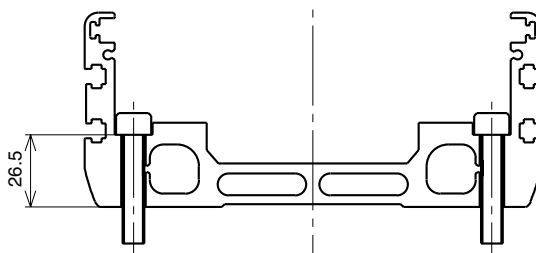


Fig. 10-6

1-2-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

Recommended torque 22.5N·m to 36.3N·m (230kgf·cm to 370kgf·cm)

1-2-4 Installation methods

⚠ WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

- Tap M8 holes into the installation base where the robot is to be installed. Refer to the XY-X Series catalog for the hole positions.
- Remove the screws fixing the X-axis stroke cover. (M4 countersunk head screw, 6 screws)
- Remove the stroke cover.
If the cover is difficult to remove, manually move the Y-axis to the motor side stroke end. The cover will be easier to remove.
- Fix the robot onto the installation base with the designated bolts.

5) **⚠ CAUTION**

Take care not to catch the X-axis wiring when installing the stroke cover.

After installing, return the stroke cover and X-axis wiring box to the original positions.

1-3 Installation method 3 (Gantry type support axis)

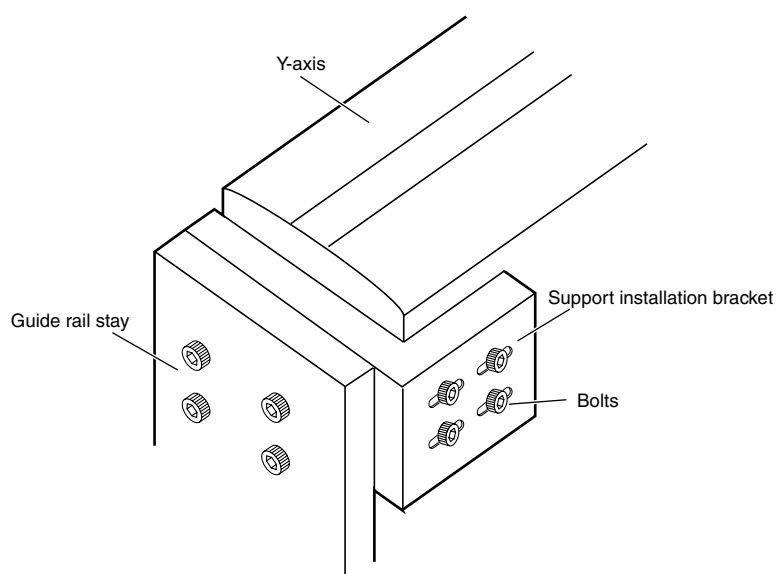
Install the gantry type support axis in the following manner.

CAUTION

Move the X-axis as much as possible, and tighten the bolts where the movement is the lightest.

Set the X-axis and guide rail parallelism during installation. Make sure that there is no difference in the height direction of the X-axis and guide rail installation surface.

- 1) Fix the robot onto the specified position of the installation base with bolts.**
Do not tighten the guide rail bolt at this time. Securely fix the X-axis section onto the installation base.
- 2) When the ZR-axis is provided, or if tools are already attached, move as close to the X-axis side as possible so that a load is not applied on the guide rail.**
- 3) Loosen the bolt for the Y-axis and support installation bracket. (Refer to following drawing.)**
- 4) Temporarily fix the guide rail onto the installation base with bolts.**
The parallelism of the guide rail and X-axis must be set using a dial gauge or pick gauge, etc.
- 5) To easily set the parallelism, first tighten the bolt loosened in step 3).**
Set the X-axis near one end, and tighten the bolt on the guide rail end in this state. Next, move the X-axis to the opposite end, and tighten the bolt on the opposite side of the guide rail in this state. Repeat this until all bolts have been tightened.



Adjustment of gantry type support rail

2 Protective Connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground tap with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground terminal is located on the inside of the X-axis wiring box. (Refer to Fig. 10-7 and Fig. 10-8.)

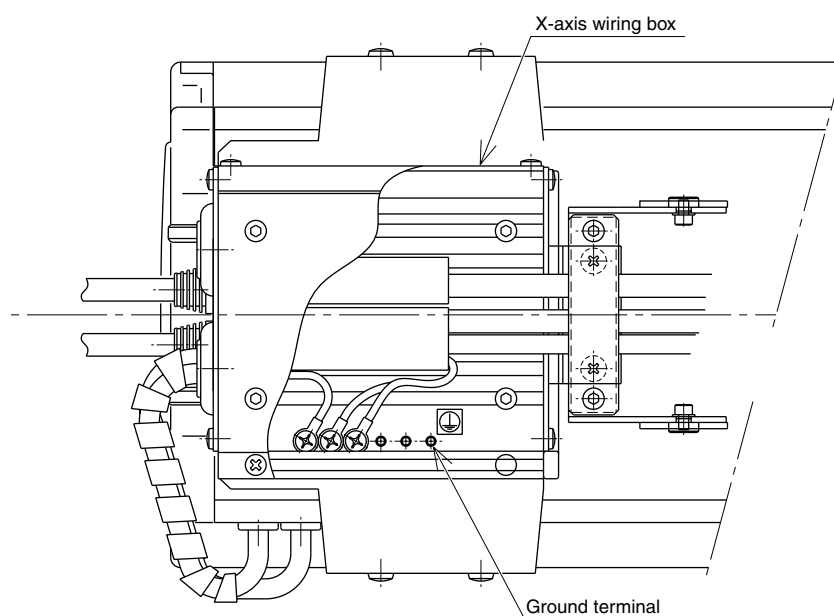


Fig. 10-7

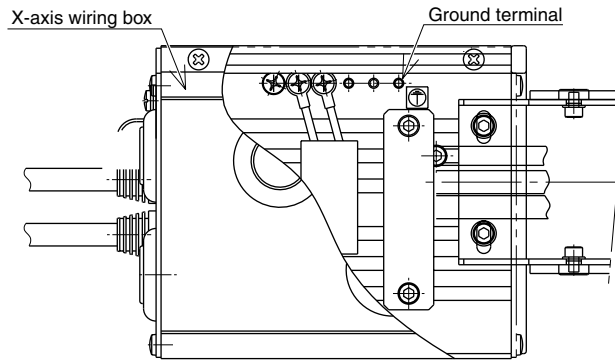


Fig. 10-8 XZ type

2-2 Ground wire

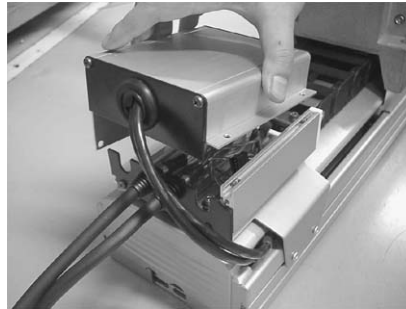
Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

2-3 Wiring methods

CAUTION

Accurately insert the lock washer between the ring-tongue terminal and robot. Proper continuity may not be secured if the lock washer is dislocated.

- 1) Loosen the four M4 small screws, and open the X-axis wiring box cover.



- 2) Open holes (or notches) in the grommets on the end face of the X-axis wiring box, and pass the ground wire through.



- 3) Connect the ring-tongue terminal of the ground wire to the ground terminal on the robot.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 10-9.)

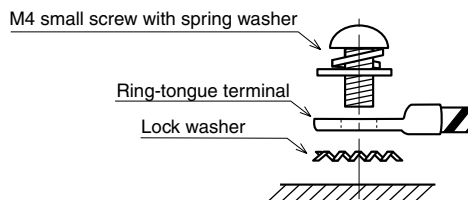


Fig. 10-9

- 4) Return the X-axis wiring box cover to the original position.

3 Installing the Tool

Install the user tool onto the robot's tool installation surface in the following manner.

⚠ WARNING

Always turn the controller power OFF before Installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

3-1 Arm type, gantry type 2-axis model

Eight M8 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider installation surface. (Refer to Fig. 10-10.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

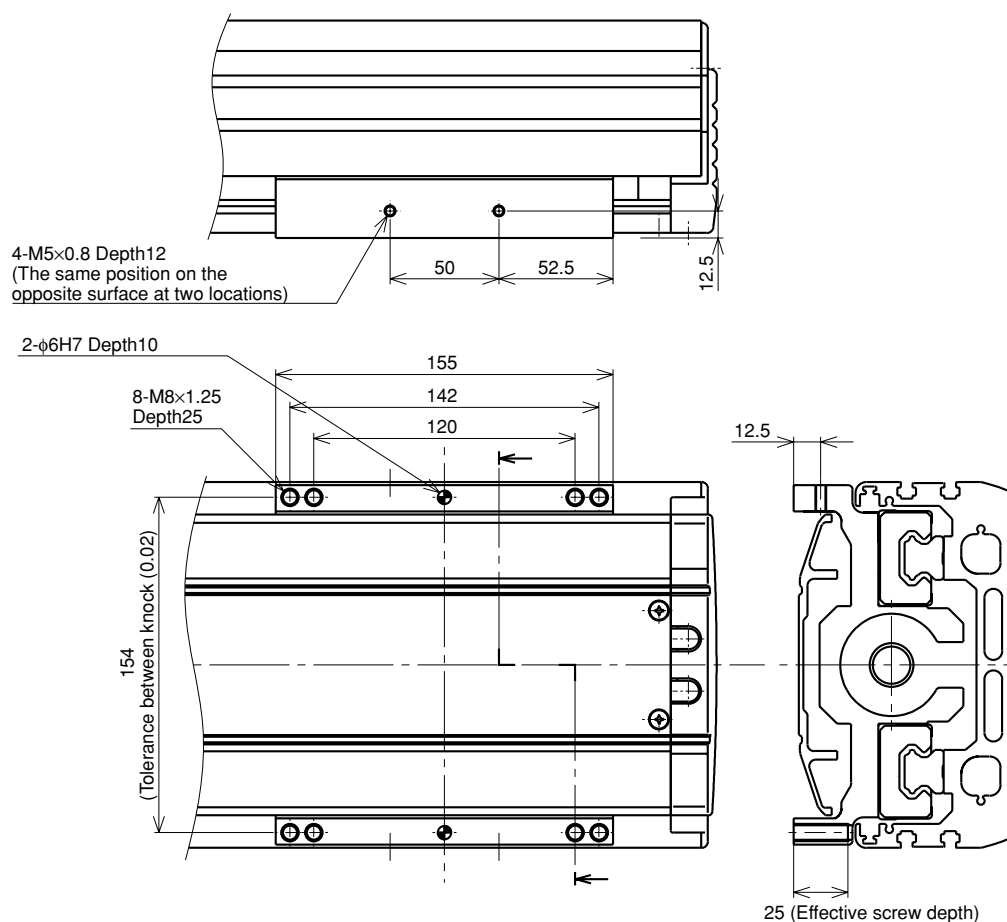


Fig. 10-10 HXYX arm type, gantry type

CAUTION

If the fitting length is less than 16mm, the threads could be damaged during tightening. Note that if the fitting length exceeds 25mm, the bolt end could contact the cover.

Select the nominal length of the tool fixing bolt so that the fitting length of the screw fixing the tool is 16mm or more, 25mm or less. (Refer to the cross-section drawings in Fig. 10-10.)

3-2 Moving arm type 2-axis model

The moving arm type has an aluminum-cast bracket on the end of the Y-axis. Install the tool on this bracket.

Twelve M8 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the bracket.

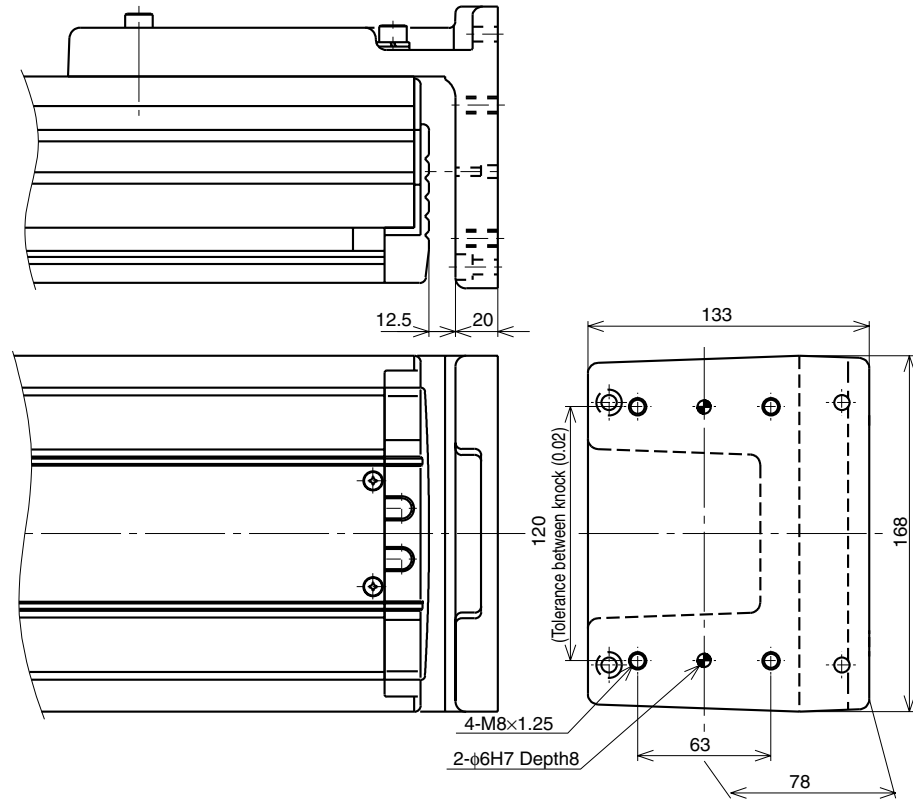


Fig. 10-11 HXYX moving arm type

CAUTION

If the fitting length is less than 16mm, the threads could be damaged during tightening. If the fitting length is longer than 30mm, the screw could contact the Y-axis.

Select the minimum fixing bolt screw length so that the screw fitting length is 16mm or more.

3-3 Pole type 2-axis model

Four M8 coarse thread tap holes and two $\phi 8$ reamer holes are opened on the tool installation surface of the Y-axis slider. (Refer to Fig. 10-12.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

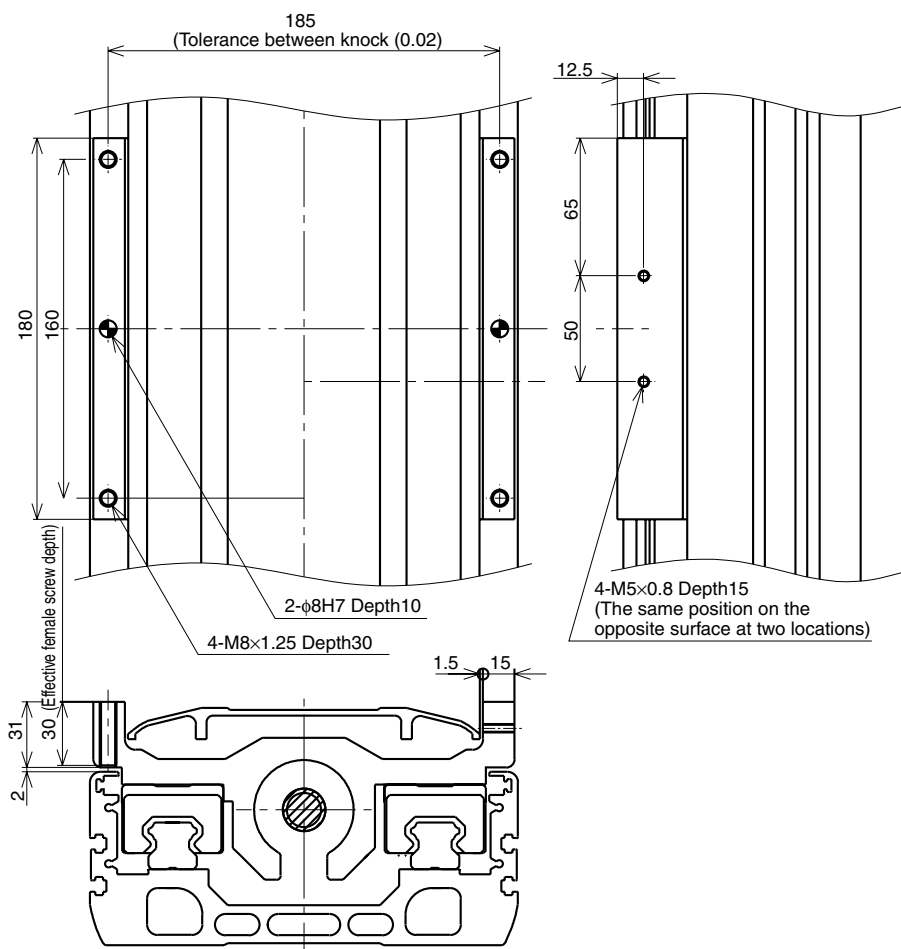


Fig. 10-12 HXYX pole type

CAUTION

If the screw's fitting length is less than 16mm, the screw threads could be damaged during tightening. If the screw length from the installation surface is longer than 30mm, the screw end could contact the frame.

Select the under head length of the bolt fixing the tool so that the screw length from the slider installation surface is 16mm or more, 30mm or less.

3-4

ZH
**(Arm type, gantry type, moving arm type 3rd-axis option/
 XZ type 2-axis model)**

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the screw length exceeds 27mm from the installation surface, the screw could contact the bottom.

When using the 3rd-axis model with ZH for the 3rd-axis, install the workpiece onto the ZH frame in the following manner.

M6 coarse thread tap holes are opened on the frame's workpiece installation surface. Install the tool using these holes. The tap depth is 10mm.

Select the under head length of the installation bolt so that the screw length from the installation surface is 9mm or more, 27mm or less.

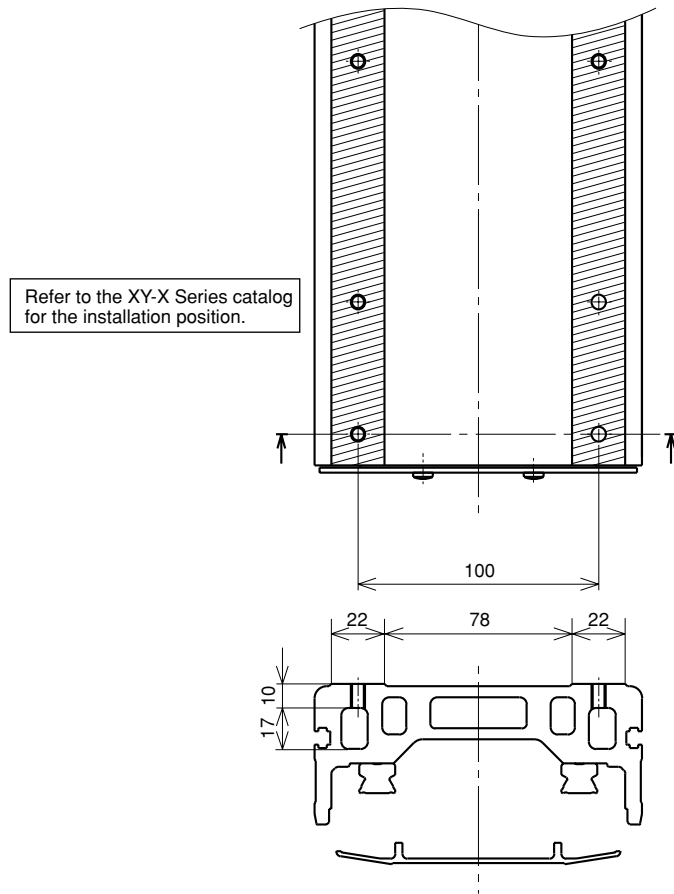


Fig. 10-13 Tool installation ZH

NOTE

There is a step on the ZH frame.
 The actual tool installation surface is the shaded section shown above.

3-5

ZL**(Arm type, gantry type, moving arm type 3rd-axis option/
XZ type 2-axis model)**

When using the 3rd-axis model with ZL for the 3rd-axis, install the workpiece onto the ZL slider in the following manner.

Eight M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider. (Refer to Fig. 10-14.) Install the user tool onto the ZL slider using these holes.

Four M5 coarse thread tap holes are opened on the side of the slider. Use these to fix loads other than the tool, such as the wire retainer.

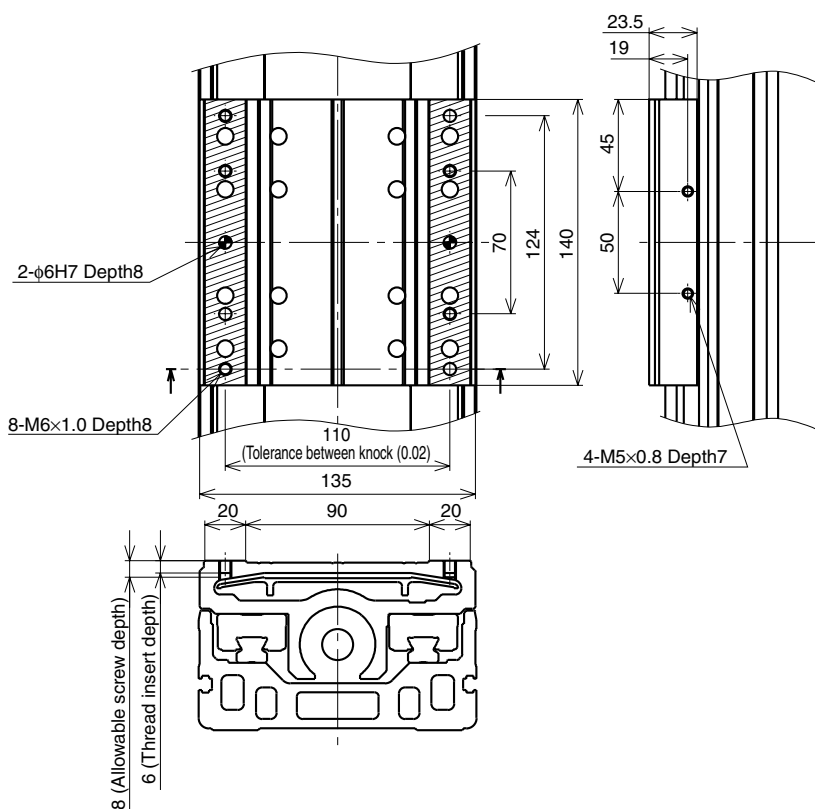


Fig. 10-14 ZL

CAUTION

If the fitting length is less than 6mm, the threads could be damaged during tightening. If the fitting length is longer than 8mm, the end of the screw could contact the cover stroke.

NOTE

There is a step on the top of the slider. The actual tool installation surface is the shaded section shown above.

Select the nominal length of the bolt for fixing the tool so that the screw fitting length is 6mm or more, 8mm or less. (Refer to the cross-section drawing in Fig. 10-14.)

3-6 ZPH (Pole type 3rd-axis option)

When ZPH is attached for the 3rd-axis of the pole type, install the tool onto the aluminum bracket at the end of the ZP-axis.

Twelve M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the bracket.

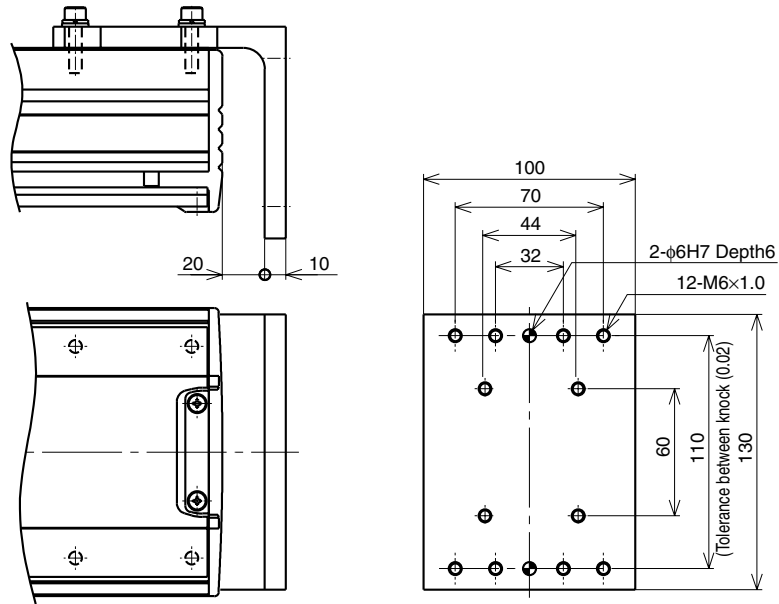


Fig. 10-15 ZPH

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the bolt screw length exceeds 30mm from the installation surface, the screw could contact the Y-axis.

Select the minimum nominal length of the fixing bolt so that the length is 9mm or more from the tool installation surface.

3-7

RH

(Arm type, moving arm type, gantry type 4th-axis option/
XZ type 3rd-axis option)

CAUTION

When fixing with the tap holes, always fix at several holes. If fixed with only one hole, the loosening torque could act during operation can cause loosening.

If the rotary axis RH is attached to the 4th-axis, install the tool onto the shaft at the end of RH.

Five M8 coarse thread tap holes are opened on the end of the shaft. Install the tool using these holes. The tool can also be installed with a bolt coupling or split clamp using the outer diameter of the shaft.

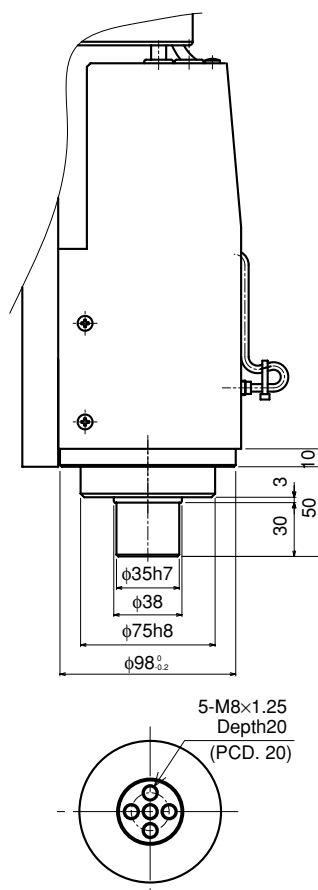


Fig. 10-16 RH

NOTE

The φ75 section shown below is the non-movable section. The rotary shaft is the section below φ38.

4 User Wiring and User Piping

⚠ WARNING

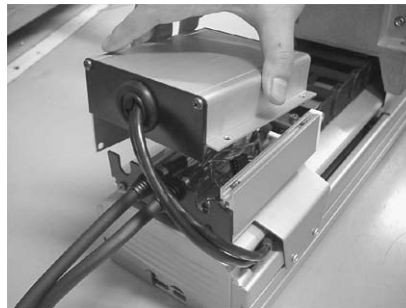
Always turn off the controller before wiring and piping to prevent electrical shocks.

4-1 Cable carrier type

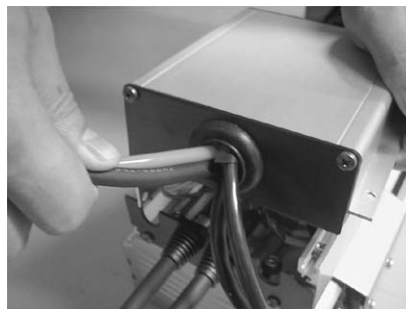
A cable carrier is mounted as a standard between the X and Y axes. When 3rd-axis are used, a cable carrier is also provided between the Y and Z axes, and when using 4th-axis, a cable carrier is also provided between the Z and R axes. Lay the wiring and piping to the tool using these ducts. A 0.3sq 10-core flexible cable is wired from the X-axis wiring box to the final axis' wiring box, and can be used freely. The wiring and piping methods for a 2-axis arm type are explained below as an example.

4-1-1 Example of wiring and piping methods using cable carrier

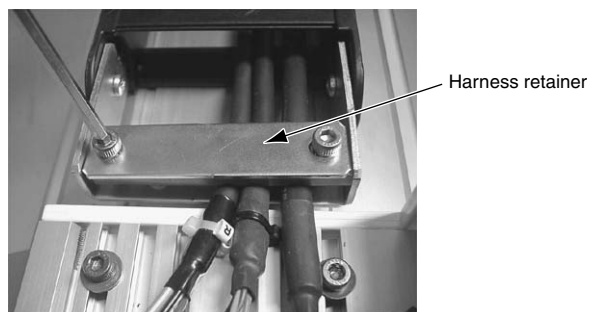
- 1) Remove the four M4 small screws and open the X-axis wiring box cover.



- 2) Rubber grommets are attached to the end face of X-axis wiring box. Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through.



- 3) Remove the harness retainer located at the cable carrier outlet. (Hexagon socket bolt M5, 2 bolts)



- 4) Pass the required wires and pipes through the cable carrier.



The cable carrier has an outer lid that can be opened and closed easily. Use a flat-tip screwdriver to open the lid. Press this lid in to close it.



- 5) Open the Y-axis wiring box cover, and lay the required wiring and piping.

6) **CAUTION**

1. The wires could be damaged if the harness retainer is tightened too much.
2. Manually move the robot by the full stroke before fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.

When completed with the wiring, fix with the harness retainer in the wiring box.

7) **CAUTION**

Take care not to catch the harness or air tube with the cover.

Return each wiring box cover to the original position.

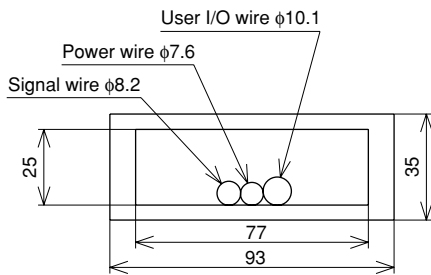
4-1-2 Cable carrier specifications

CAUTION

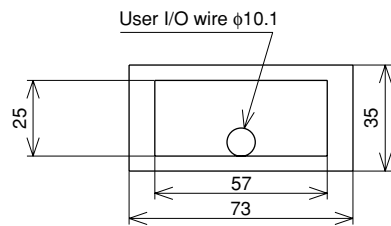
When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area. (This ratio is called the cable carrier space factor.)

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

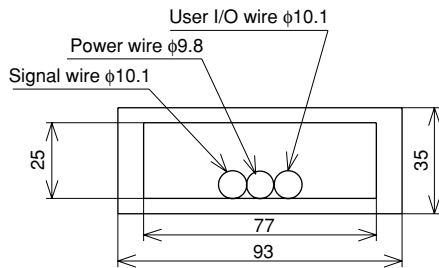
2-axis specifications X-Y cable carrier



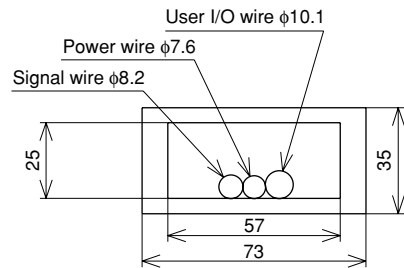
2-axis I/O specifications Y-axis cable carrier



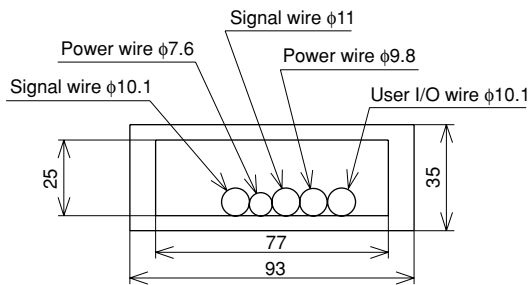
3-axis specifications X-Y cable carrier



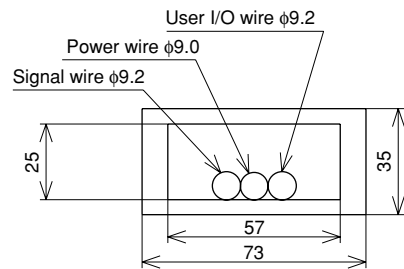
XZ type 2-axis specifications X-Z cable carrier
3-axis specifications Y-Z cable carrier



4-axis specifications X-Y cable carrier



XZ type 3-axis specifications X-Z cable carrier
4-axis specifications Y-Z cable carrier



XZ type 3-axis specifications
4-axis specifications Z-R cable carrier

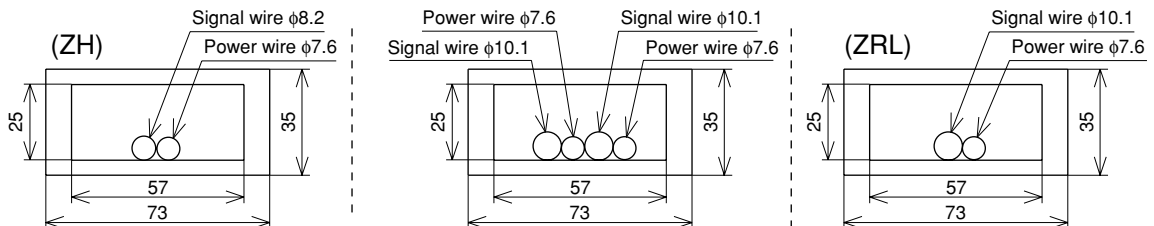


Fig. 10-17

4-1-3 User I/O cable specifications

⚠ CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

With the cable carrier specifications, signal wires ($0.3\text{mm}^2 \times 10$ wires) that can be used freely by the user are laid as a standard between the X-axis wiring box and final axis' wiring box.

Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed. Attach these to the user wiring to eliminate wiring led through the robot.

Crimp the enclosed pins onto the user wiring, and insert into the connector.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

Refer to "1-2. User I/O wiring" in Chapter 5 "Specifications" for details on the wiring specifications.

4-2 Whipover cable type

CAUTION

Do not clamp the wires or tubes to the outside of the independent cable. The independent cable could sag or break and ultimately be disconnected.

The signal wires (0.3mm² × 7 wires) and air tubes (4 × 2.5, 2 tubes) are incorporated in the Whipover cable. Use these to wire and pipe to the tool.

| Part No. | Part name | Part No. | Qty. |
|----------|--------------|----------------|------|
| 1 | SM connector | SMR-10V-B | 1 |
| 2 | SM connector | SMP-10V-BC | 1 |
| 3 | Contact | SYM-001T-0.6 | 7 |
| 4 | Contact | SHF-001T-0.8BS | 7 |
| 5 | Cable | | 1 |

| Signal | Connector | NO | NO | Connector | Remarks |
|---------------------|-----------|----|----|-----------|---------|
| General-purpose I/O | ① | 1 | 1 | ② | Brown |
| | | 2 | 2 | | Red |
| | | 3 | 3 | | Orange |
| | | 4 | 4 | | Blue |
| | | 5 | 5 | | Purple |
| | | 6 | 6 | | Gray |
| | | 7 | 7 | | White |
| | | 8 | 8 | | |
| | | 9 | 9 | | |
| | | 10 | 10 | | |

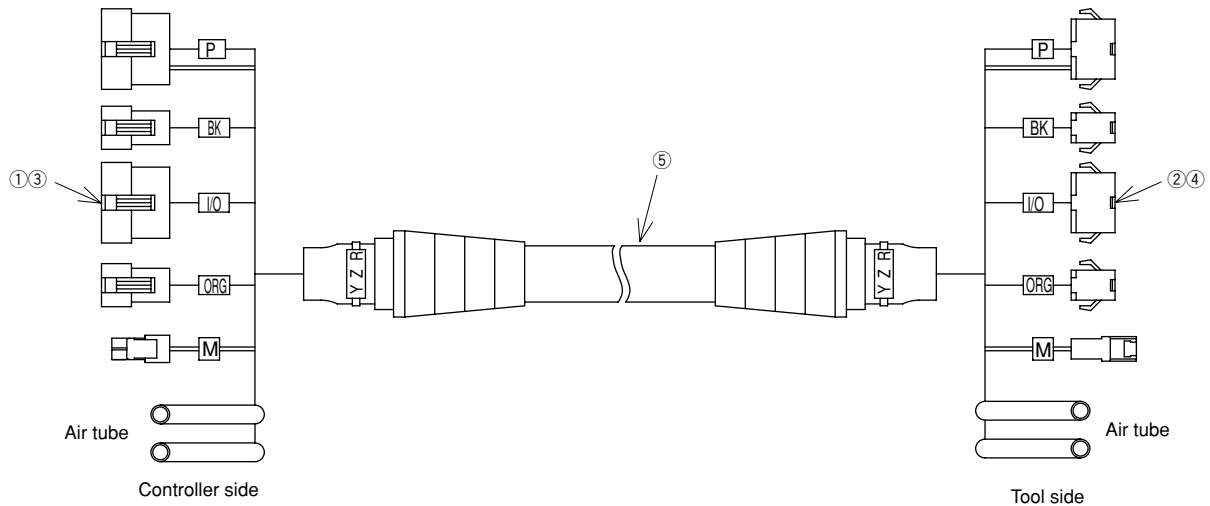


Fig. 10-18 Whipover cable user-wire specifications

4-2-1 Examples of wiring and piping with Whipover cable

CAUTION

Securely crimp the pin and insert into the pin connector. Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

- 1) Crimp the user's cable and tool wiring onto the enclosed connector. Refer to section "1-2. User I/O wire" in Chapter 5 "Specifications" for details on the enclosed connector and pin specifications.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

- 2) When using an air tube, prepare an air coupler for connecting the user air tube with the YAMAHA air tube.

- 3) Open the X-axis wiring box cover.

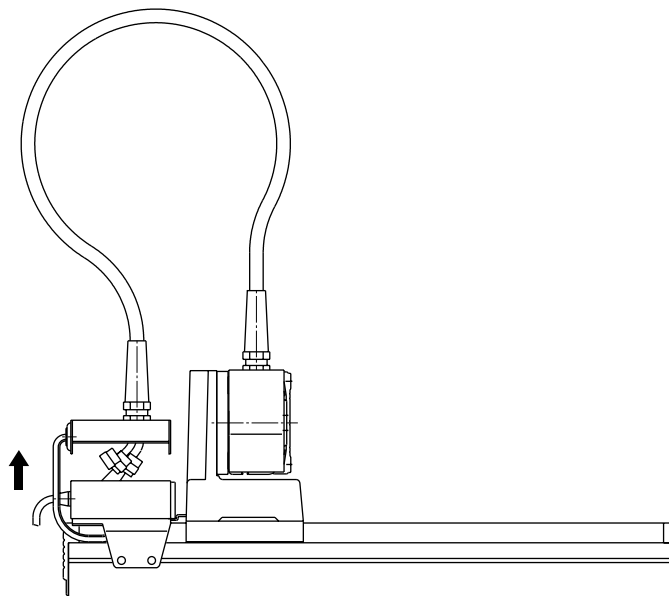


Fig. 10-19

- 4) Rubber grommets are attached to the X-axis wiring box.
Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through. Crimp the enclosed connectors onto the cables.
- 5) Connect the connectors, and connect the air tubes using the air couplers.
- 6) Open the Y-axis wiring box cover.
- 7) Rubber grommets are also attached to the Y-axis wiring box.
Open holes in these grommets, and pass the tool side cables and air tubes through.
- 8) Connect the connectors in the same manner as the X-axis, and connect the air tubes with the air couplers.
- 9) **CAUTION** _____
Take care not to catch the wiring or air couplers when installing the covers.

When completed with all wiring work, return each wiring box cover to the original positions. Sandwich the X-axis wiring and air tube with the protective material at the wire lead-out port of each wiring box.

5 Periodic Inspections

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts, turn OFF the controller, wait for a while and check that the part has cooled.

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

5-1 Replenishing grease to the linear guide

Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating “Work In Progress” so that other operators do not turn the controller power ON.
- 3) Remove the axis stroke cover when replenishing grease.
Refer to section "1. Installation" for details on opening the X-axis stroke cover.

- 4) Replenish the grease with one of the following methods.

Method 1: Using a grease gun, replenish grease from the grease nipple installed on the linear guide bearings.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the linear guide bearings and rail.

The X-axis and Y-axis each have four linear guide bearings. Replenish grease to all four bearings.

Wipe off any excessive grease that has seeped out to the rail.

Recommended grease gun: MG70 (THK X-axis, Y-axis H-type nozzle)
(THK Z-axis (ZL) N-type nozzle)

Method 2: After wiping off the grease adhered on the rail and on the bearing seal section with a rag, etc., apply a light coat of grease directly onto the guide rail with a finger.

NOTE

Due to the structure of ZH, grease can be replenished only with this method.

When replenishing grease to ZH, turn the power OFF when near the center of the stroke, and then apply grease to the top and bottom of the guide.

- 5) Return the stroke cover to the original position.

5-2 Replenishing grease to the ball screw

Prepare the following recommended grease nipple beforehand.

Recommended grease nipple : A-M6X1 type (JIS B1575)

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

Replenishment methods

Refer to the following procedures and replenish the grease.

- 1) Remove the stroke cover of the axis to which grease is to be replenished.
- 2) Replenish the grease with one of the following methods.

CAUTION

Always remove the grease nipple after replenishing the grease. Failure to do so could cause damage if the grease nipple and robot interfere.

Method 1: Install the grease nipple onto the M6 tap hole on the ball screw flange surface, and replenish grease using the grease gun.



Sufficient grease has been replenished when new grease starts to seep out to the screw shaft.

Wipe off any excessive grease.

Recommended grease gun : MG70 (THK H-type nozzle)

Method 2: After wiping off the grease adhered on the rail and on the bearing seal section with a rag, etc., apply a light coat of grease directly onto the guide rail with a finger.

NOTE

Due to the structure of ZH, grease can be replenished only with this method.

- 3) Return the stroke cover to the original position.

CHAPTER 11

FXYBX/SXYBX

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1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

Install the FXYBX by opening through holes on the installation base and securing with M5 bolts from below. (M5 tap holes are opened on the bottom of the robot.)

Install the SXYBX by opening through holes on the installation base and securing with M6 bolts from below. (M6 tap holes are opened on the bottom of the robot.)

1-1 Installation bolt types

- Use the following type of installation bolt.

| | | | |
|-------|-------------------------------|----|---------------|
| FXYBX | Hexagon socket head cap screw | M5 | Strength 8.8T |
| SXYBX | Hexagon socket head cap screw | M6 | Strength 8.8T |

1-2 Installation bolt nominal length

FXYBX

Select the under head length so that the screw length from the bottom of the robot is 8mm or more, 10mm or less.

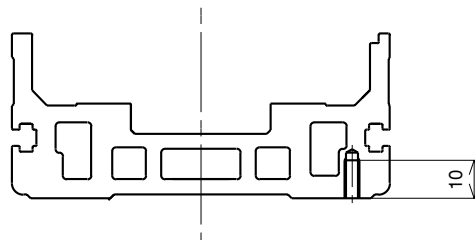


Fig. 11-1

⚠ CAUTION

Note that the screw will contact the bottom if the screw length from the robot bottom is longer than 10mm.

SXYBX

Select the under head length so that the screw length from the bottom of the robot is 9mm or more, 27mm or less.

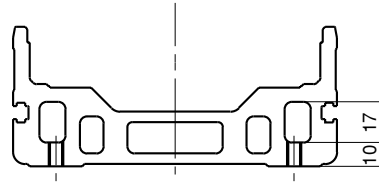


Fig. 11-2

CAUTION

Note that the screw will contact the bottom if the screw length from the robot bottom is longer than 27mm.

1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

| | | |
|-------|--------------------|------------------|
| FXYBX | Recommended torque | 60 to 90kgf·cm |
| SXYBX | Recommended torque | 100 to 130kgf·cm |

1-4 Installation methods

WARNING

Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

- 1) Open a through hole on the installation base's robot installation surface. Refer to the XY-X Series catalog for the hole positions.
- 2) Set the robot on the installation base and fix with the designated bolts from below.

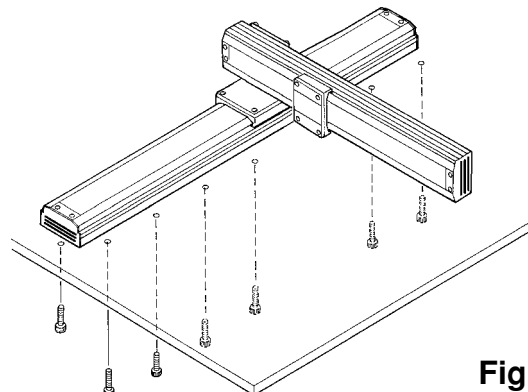


Fig. 11-3

2 Protective connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground tap with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground terminal for the cable carrier type is provided in the X-axis wiring box. (Refer to Fig. 11-4.)

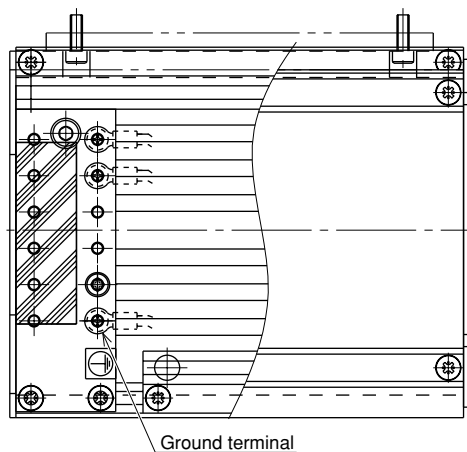


Fig. 11-4 Cable carrier model

The ground terminal for the Whipover cable type is provided on the end face of the X-axis wiring box. (Refer to Fig. 11-5.)

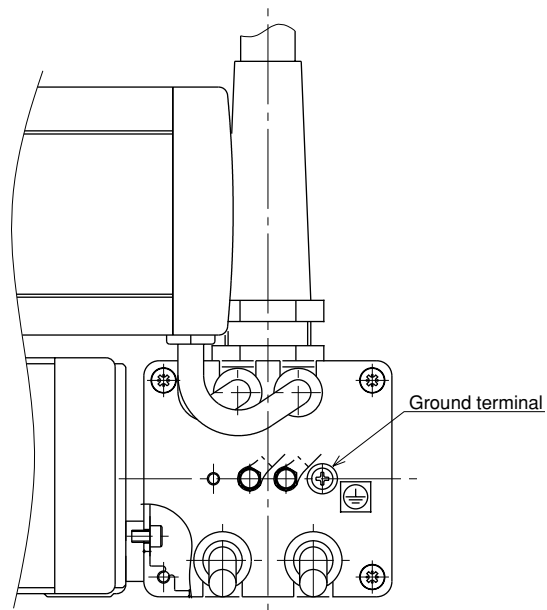


Fig. 11-5 Whipover cable type

2-2 Ground wire

Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

2-3 Wiring methods (Cable carrier type)

CAUTION

Accurately insert the lock washer between the ring-tongue terminal and robot. Proper continuity may not be secured if the lock washer is dislocated.

CAUTION

Take care not to catch the harness and ground wire from the X-axis with the cover of X-axis wiring box when installing the cover.

- 1) Remove the four M4 screws from the top of the X-axis wiring box, and loosen the M4 screw on the end face.

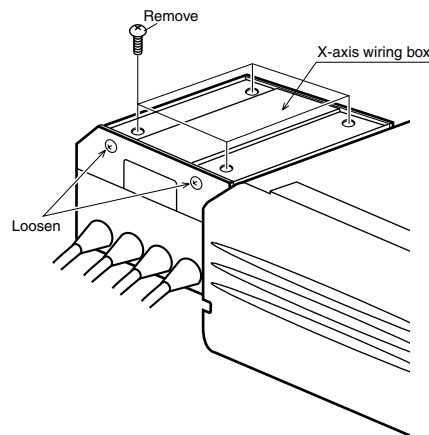


Fig. 11-6

- 2) Open the X-axis wiring box cover.
Lift up the back of the wiring box, push it forward and then pull it upward and off.

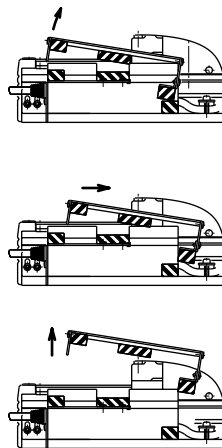


Fig. 11-7 Opening the wiring box

- 3) Connect the ground wire to the ground terminal attached to the top of the X-axis wiring box.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 11-8.)

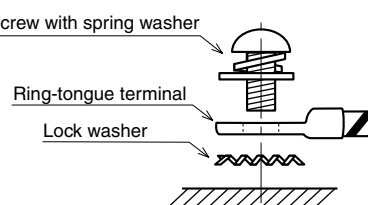


Fig. 11-8

- 4) Return the wiring box cover to the original position following steps 1 and 2 in reverse.

Lead out the ground wire from the user wiring outlet on the end face of the X-axis wiring box.

2-4 Wiring methods (Whipover cable type)

For the independent cable type, wire the ground wire to the ground terminal on the end face of the X-axis wiring box. Refer to 3). in 2-3. Wiring methods (Cable carrier type) for details.

3 Installing the Tool

Install the user tool onto the robot's tool installation surface in the following manner.

⚠ WARNING

Always turn the controller power OFF before installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

3-1 FXYBX arm type 2-axis model

Four M5 coarse thread tap holes and two $\phi 5$ reamer holes are opened on the Y-axis slider. (Refer to Fig. 11-9.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these as required.

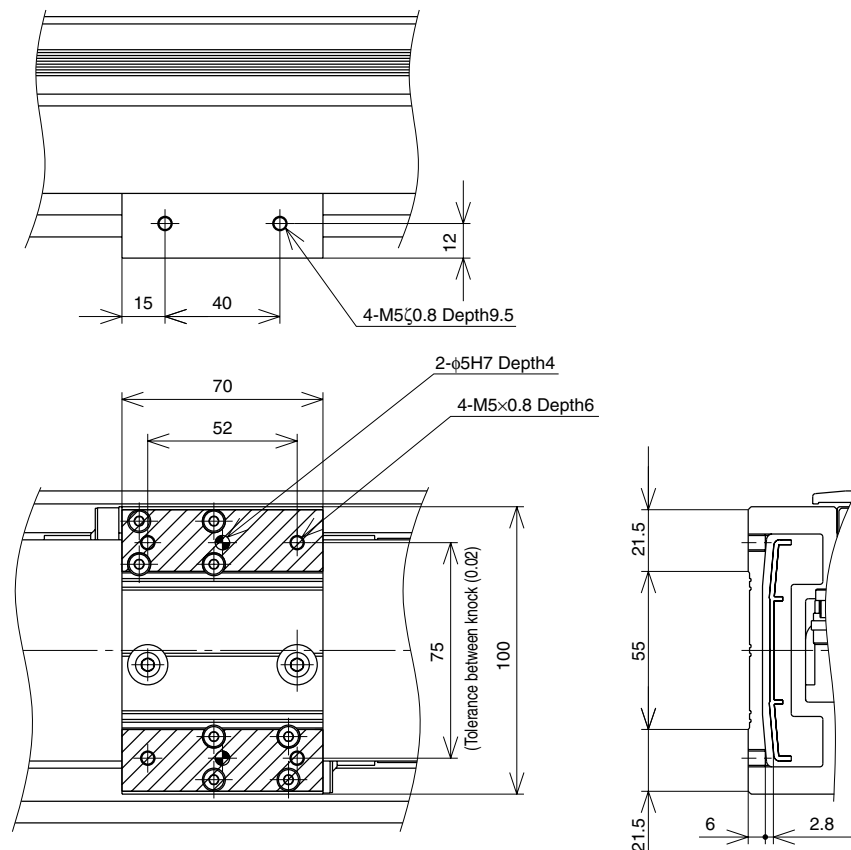


Fig. 11-9 FXYBX arm type

Select the under head length of the bolt for fixing the tool so that the screw length from the slider installation surface is 6mm or less.

CAUTION

If the screw length from the installation surface is 8mm or more, the screw could interfere with the stroke cover.

NOTE

There is a step on the top of the slider. The actual tool installation surface is the shaded section shown above.

3-2 SXYBX arm type 2-axis model

Eight M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider.(Refer to Fig. 11-10.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these as required.

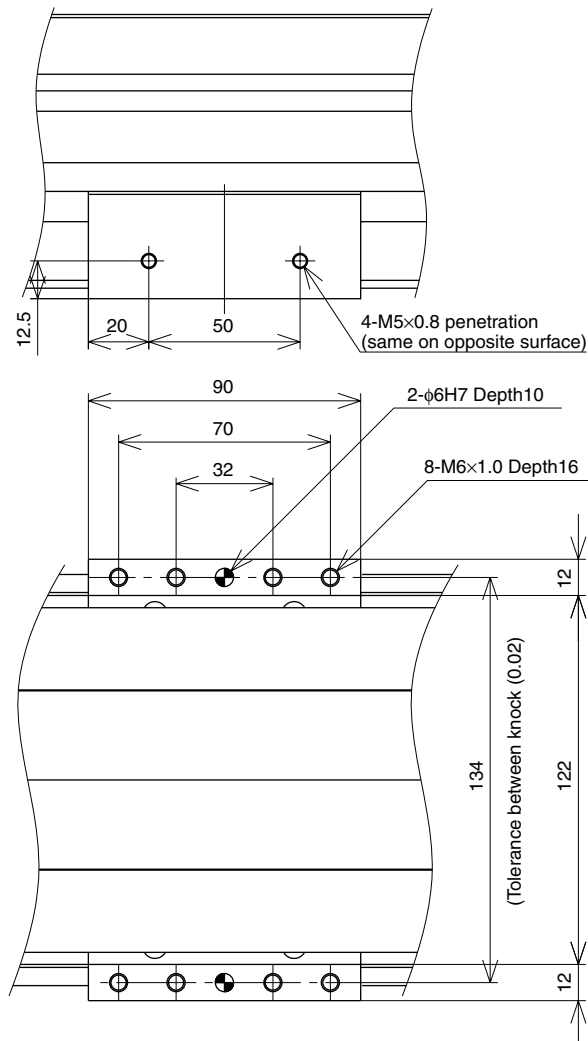


Fig. 11-10 SXYBX arm type

Select the under head length of the bolt for fixing the tool so that the screw length from the slider installation surface is 6mm or less.

CAUTION

Note that if the screw length from the installation surface is 16mm or more, the screw will contact the bottom.

3-3

SXYBX-ZF (XZ type 2-axis, arm type 3rd-axis option)

When using the XZ type 2-axis model or if ZF is attached for the arm type 3rd-axis model, install the workpiece onto the ZF slider in the following manner.

Four M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the slider's workpiece installation surface. Use these to install the tool.

Four M5 coarse thread tap holes are also opened on the slider side. Use these as required.

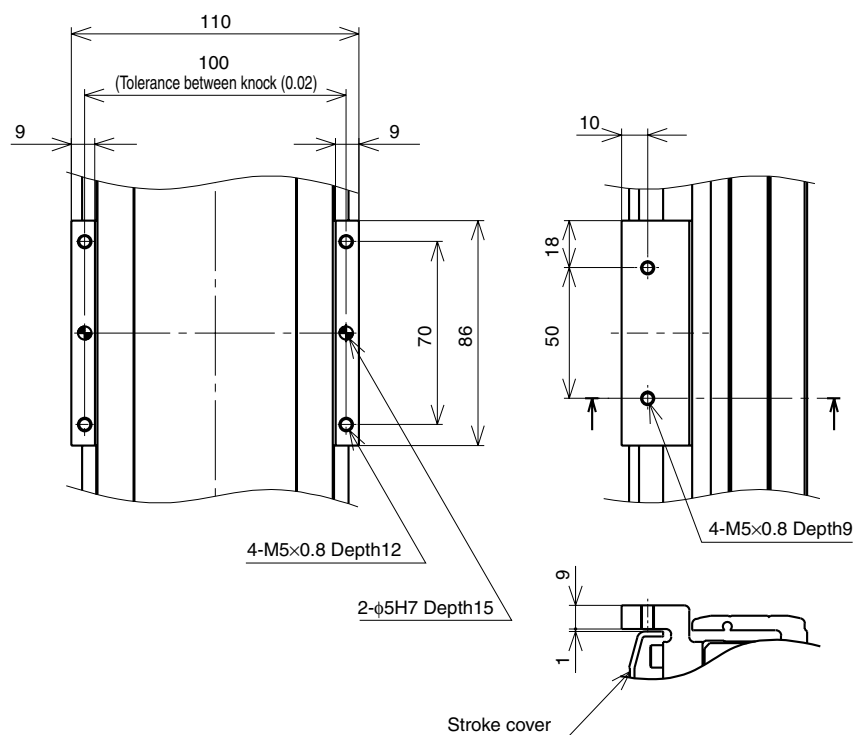


Fig. 11-11 ZF

Select the maximum length so that the screw length of the tool fixing bolt is 12mm or less.

The screw fitting length should be 8mm or more.

CAUTION

Note that if the screw length from the installation surface is 12mm or more, the screw will contact the bottom.

3-4 ZS/ZRS (FXYBX, SXYBX 3/4-axis option)

⚠ WARNING

Use the tap hole on the end of the shaft only to prevent the tool from dislocating.

Do not use only this hole to install the tool. The tool could dislocate and fly off the installation section during robot operation.

When the ZS or ZRS unit is attached to the 3rd or 4th-axis, install the tool onto the ZS or ZRS shaft in the following manner. (The ZS and ZRS shaft have the same shape.)

Use the $\phi 12$ section on the shaft, and fix the tool with a bolt coupling or split clamp.

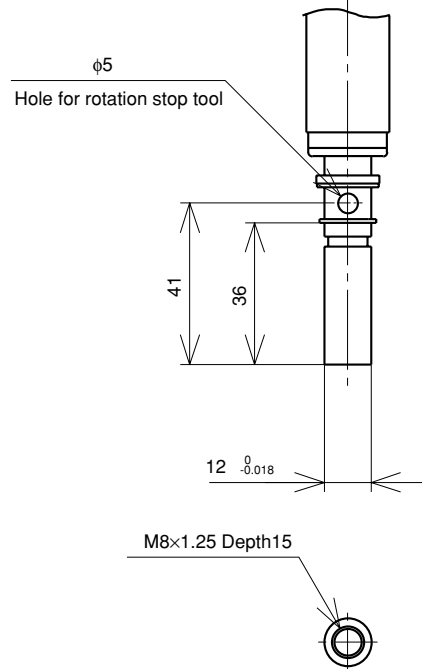


Fig. 11-12 Tool installation ZS/ZRS

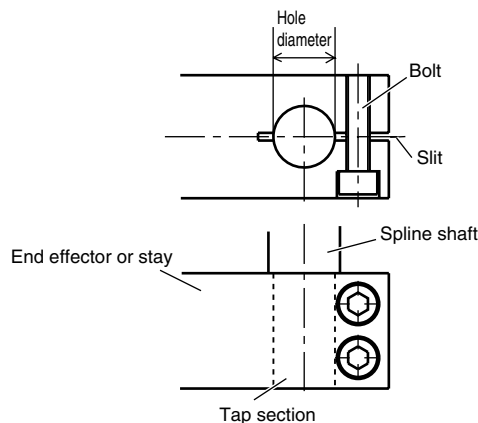


Fig. 11-13

| | |
|-------------------|--------------------|
| Example : | For split clamp |
| Recommended bolt | M4 or more |
| Quantity | 2 or more |
| Tightening torque | 4.5N·m (46kgfm) |
| Hole diameter | $\phi 12^{+0.018}$ |

3-5

ZFH**(Arm type, gantry type, moving arm type 3rd-axis option)
XZ 2nd-axis option**

When using the 3rd-axis model with ZFH for the 3rd-axis, install the workpiece onto the ZFH frame in the following manner.

Four M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the frame's workpiece installation surface. Install the tool using these holes. The tap depth is 9mm.

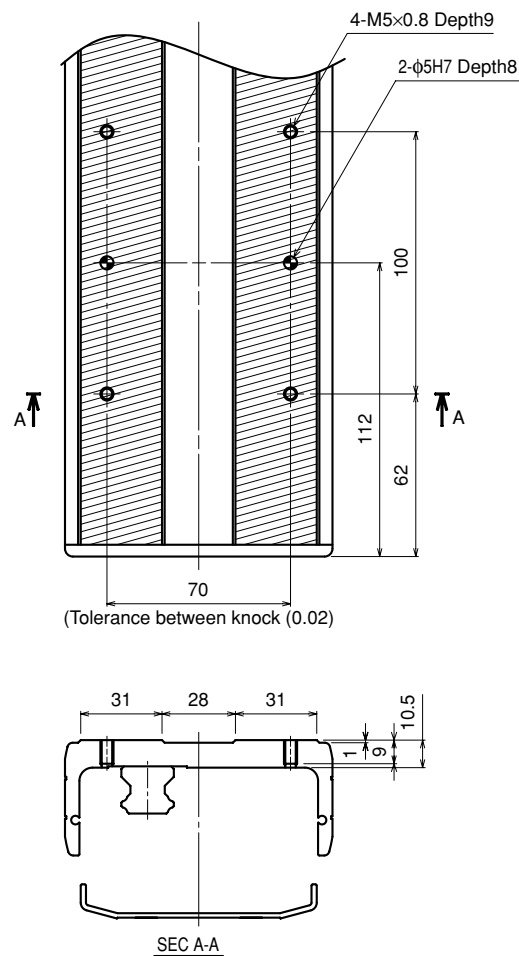


Fig. 11-14 Tool installation ZFH

NOTE

There is a step on the ZFH frame.

The actual tool installation surface is the shaded section shown above.

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the screw length exceeds 27mm from the installation surface, the screw could contact the bottom.

3-6

ZFL

(Arm type, moving arm type, 3rd-axis option/XZ type 2-axis model)

When using the 3rd-axis model with ZFL for the 3rd-axis, install the workpiece onto the ZFL slider in the following manner.

Six M5 coarse thread tap holes and a $\phi 5$ reamer hole are opened on the slider's workpiece installation surface. Install the tool using these holes. Six M5 coarse thread tap holes are opened on the slider side. Use these as required to fix light loads other than the tool, such as the wiring retainer.

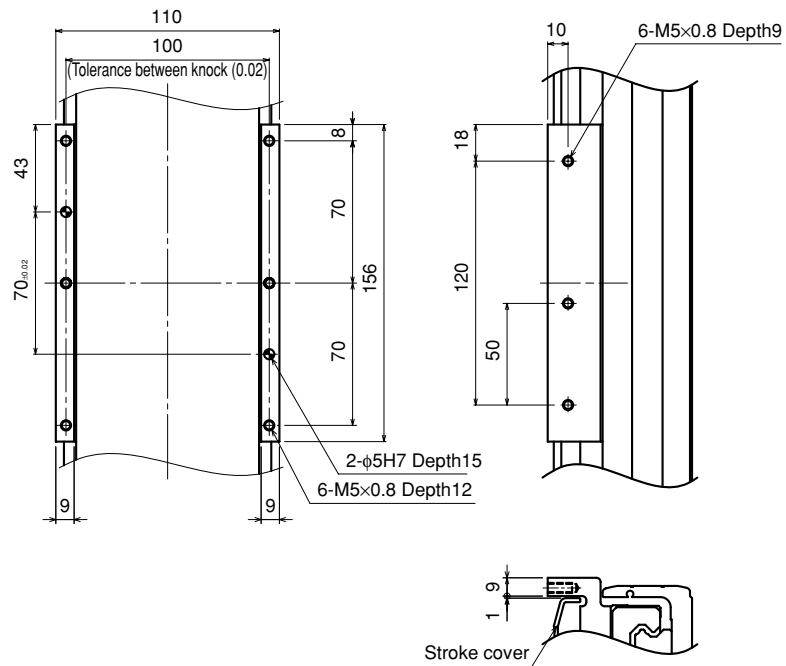


Fig. 11-15 ZFL

Select the maximum nominal length of the tool fixing bolt so that the screw fitting length is 12mm or less.

YAMAHA recommends a screw fitting length of 8mm or more.

CAUTION

If the bolt fitting length is 12mm or more from the installation surface, the bolt will contact the bottom.

4 User Wiring and User Piping

⚠ WARNING

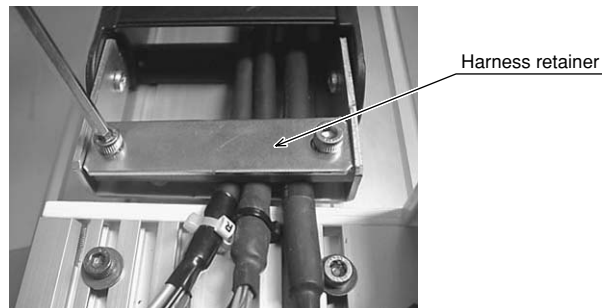
Always turn off the controller before wiring and piping to prevent electrical shocks.

4-1 Cable carrier type

A cable carrier is mounted as a standard between the X and Y axes. When using 3-axes, a cable carrier is also provided between the Y and Z axes. Lay the wiring and piping to the tool using these ducts. A 0.3sq 10-core flexible cable is wired from the X-axis wiring box to the final axis' wiring box, and can be used freely. (Refer to the "User wiring specifications" at the end of this section for details.) The wiring and piping methods for a 2-axis arm type are explained below as an example.

4-1-1 Example of wiring and piping methods using cable carrier

- 1) Open the X-axis wiring box cover. (Refer to 2-3. Wiring methods in Chapter 2. Protective Connections.)
- 2) Remove the harness retainer located at the cable carrier outlet. (Hexagon socket bolt M5, 2 bolts)



- 3) Pass the cables and air tubes through the cable carrier. The cable carrier has an outer lid that can be opened and closed easily. Use a flat-tip screwdriver to open the lid. Press this lid in to close it. Open and close this lid as necessary.



- 4) Open the Y-axis wiring box cover.
- 5) Lay out the wiring in the Y-axis box as necessary.

6) **CAUTION**

1. The wires could be damaged if the harness retainer is tightened too much.
2. Manually move the robot by the full stroke before fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.

After leading all wires, fix the wires with the harness retainer.

7) **CAUTION**

Take care not to catch the harness or air tube with the cover.

Assemble the wiring box cover at the original position.
State of X-axis wiring box when wiring is completed



State with cover installed

4-1-2 Cable carrier specifications

⚠ CAUTION

When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area. (This ratio is called the cable carrier space factor.)

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

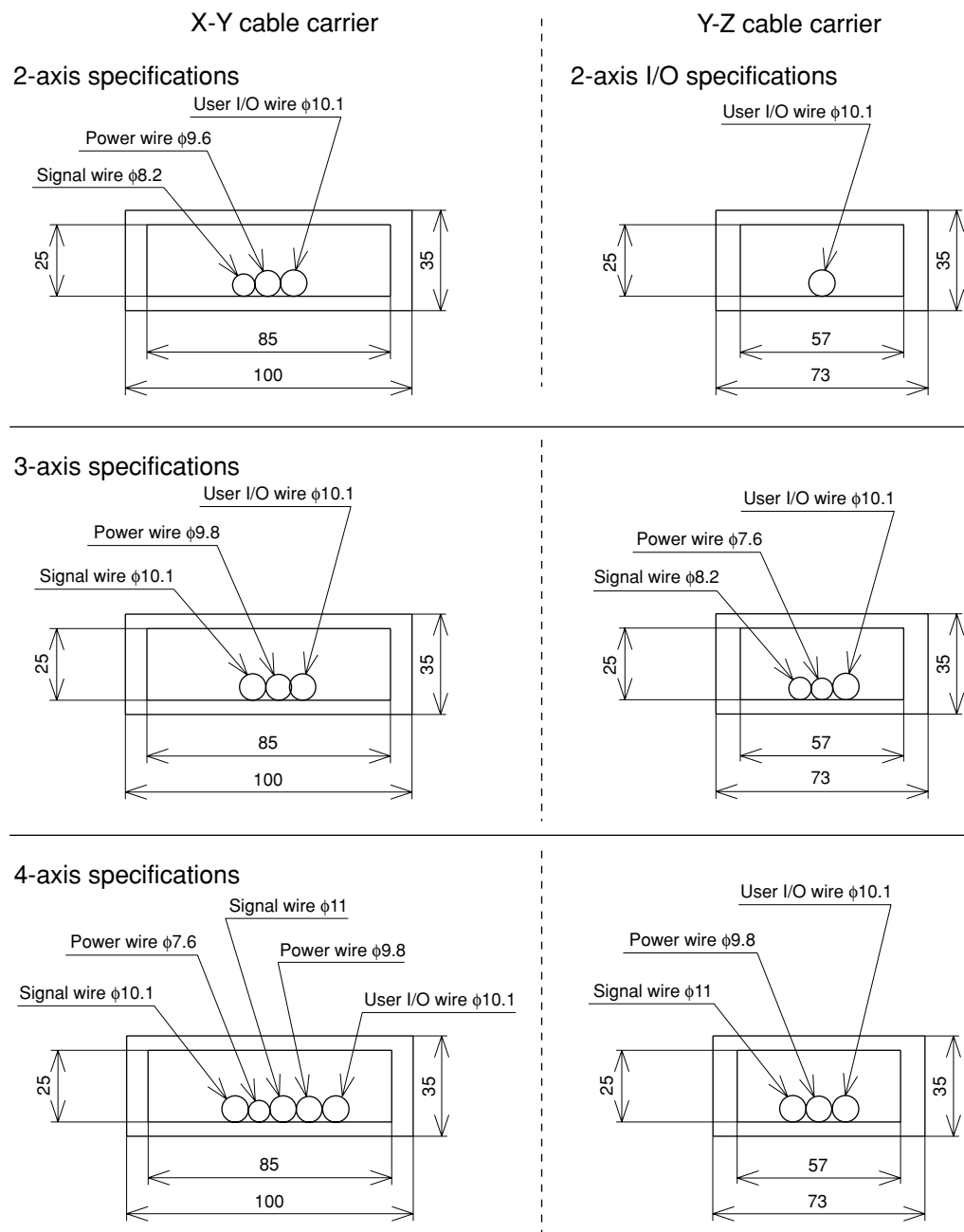


Fig. 11-16

4-1-3 User I/O cable specifications

CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

With the cable carrier model, signal wires ($0.3\text{mm}^2 \times 10$ wires) that can be used freely by the user are laid as a standard between the X-axis wiring box and final axis' wiring box (the Z-axis wiring box when using 3-axis specifications). Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed. Attach these to the user wiring to eliminate wiring led through the robot.
Crimp the enclosed pins onto the user wiring, and insert into the connector.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

Refer to "1-2. User I/O wiring" in Chapter 5 "Specifications" for details on the wiring specifications.

4-2 Whipover cable type

CAUTION

Do not clamp the wires or tubes to the outside of the independent cable. The independent cable could sag or break and ultimately be disconnected.

The signal wires ($0.3\text{mm}^2 \times 7$ wires) and air tubes (4×2.5 , 2 tubes) are incorporated in the Whipover cable. Use these to wire and pipe to the tool.

| Part No. | Part name | Part No. | Qty. |
|----------|--------------|----------------|------|
| 1 | SM connector | SMR-10V-B | 1 |
| 2 | SM connector | SMP-10V-BC | 1 |
| 3 | Contact | SYM-001T-0.6 | 7 |
| 4 | Contact | SHF-001T-0.8BS | 7 |
| 5 | Cable | | 1 |

| Signal | Connector | NO | NO | Connector | Remarks |
|---------------------|-----------|----|----|-----------|---------|
| General-purpose I/O | ① | 1 | 1 | ② | Brown |
| | | 2 | 2 | | Red |
| | | 3 | 3 | | Orange |
| | | 4 | 4 | | Blue |
| | | 5 | 5 | | Purple |
| | | 6 | 6 | | Gray |
| | | 7 | 7 | | White |
| | | 8 | 8 | | |
| | | 9 | 9 | | |
| | | 10 | 10 | | |

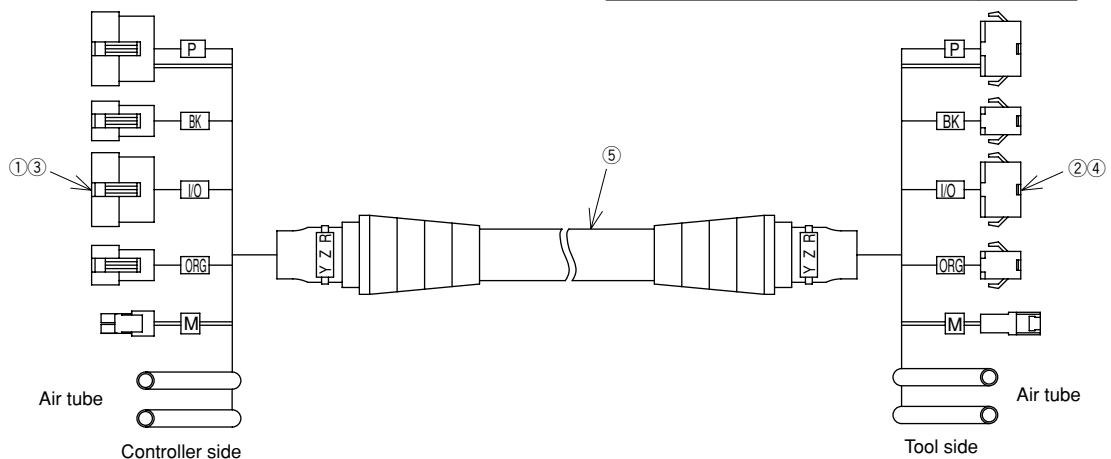


Fig. 11-17 Whipover cable user-wire specifications

4-2-1 Examples of wiring and piping with Whipover cable

⚠ CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

- 1) Crimp the user's cable and tool wiring onto the enclosed connector.
Refer to section "1-2. User I/O cable" in Chapter 5 "Specifications" for details on the enclosed connector and pin specifications.
- 2) When using an air tube, prepare an air coupler for connecting the user air tube with the YAMAHA air tube.
- 3) Remove the resin cover from the end face of the X-axis wiring box. (M4 screw, 4 screws)
- 4) Rubber grommets are attached to the X-axis wiring box.
Open holes (or notches) in these grommets, and pass the required cables and air tubes, etc., through. Crimp the enclosed connectors onto the cable beforehand.
- 5) Pull the I/O connector and air tube out of the X-axis wiring box. In the same manner, pull the user cable and air tube passed in step 4) out from the wiring box.

⚠ CAUTION

Carefully pull out the minimum length of wiring and air tube with which connections can be made.
If these are pulled with force, trouble such as dislocation or pin faults could occur.

- 6) Connect the connectors, and connect the air tubes using the air couplers.
Return the air tube into the wiring box after connecting.
- 7) Open the Y-axis wiring box cover. (M4 screw, 4 screws)
- 8) Set the required cables and air tubes, etc., into the Y-axis wiring box.
Crimp the enclosed connectors onto the cable beforehand.
- 9) Connect the connector in the same manner as the X-axis, and connect the air tube using an air coupler, etc.
If wires are led out from the Y-axis wiring box, use the rubber grommet attached to the upper cover of the Y-axis wiring box.

- 10) When completed with all wiring work, return each wiring box cover to the original positions. Sandwich the X-axis wiring and air tube with the protective material at the wire lead-out port of each wiring box.

CAUTION

Take care not to catch the wiring or air couplers when installing the covers.

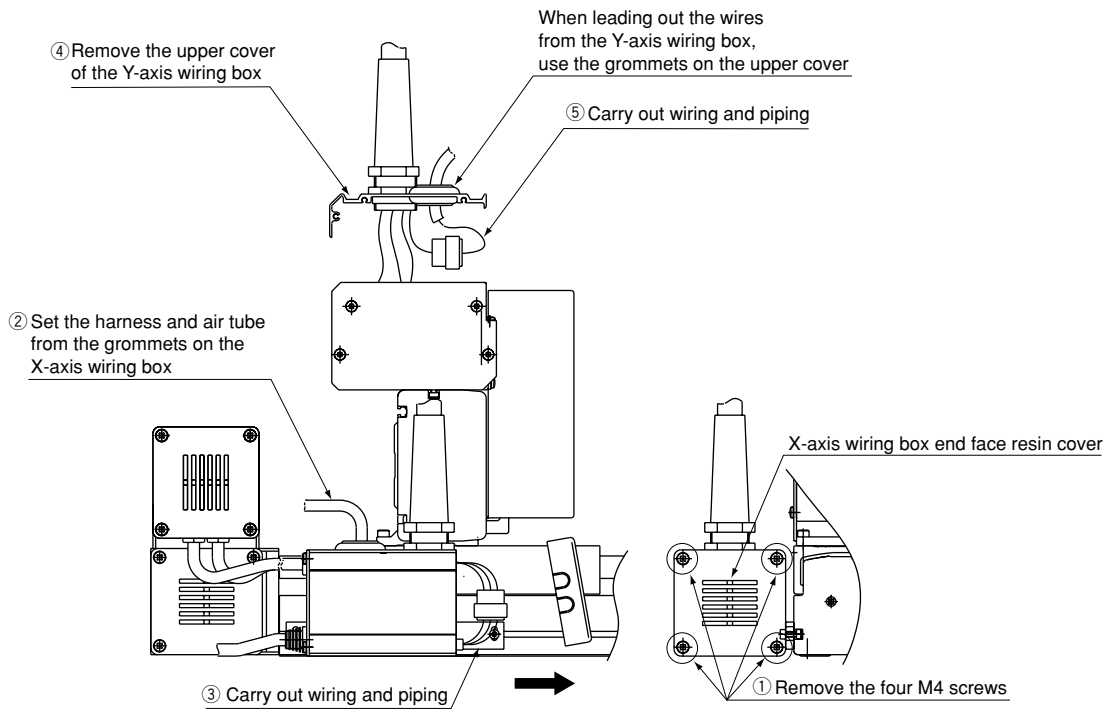


Fig. 11-18

5 Changing the Motor Installation Position

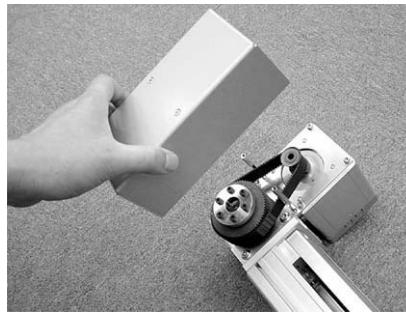
5-1 Changing the motor installation position

⚠ WARNING

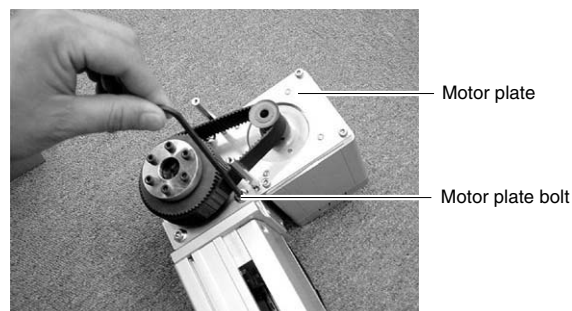
Always turn the controller power OFF before starting this work. Serious accidents could occur if the robot starts moving during this work.

The position for installing the FXYBX and SXYBX axis on the motor can be freely selected. Interference with the motor case can be suppressed to a minimum and space can be used effectively. The methods for changing the motor installation position are described below.

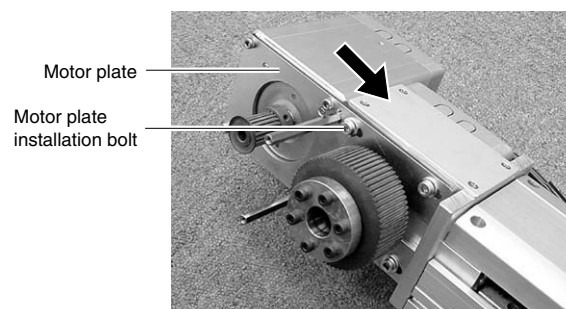
- 1) Remove the screws securing the belt cover, and remove the cover.



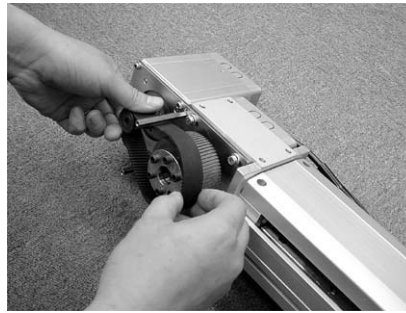
- 2) Remove the four bolts installing the motor plate.



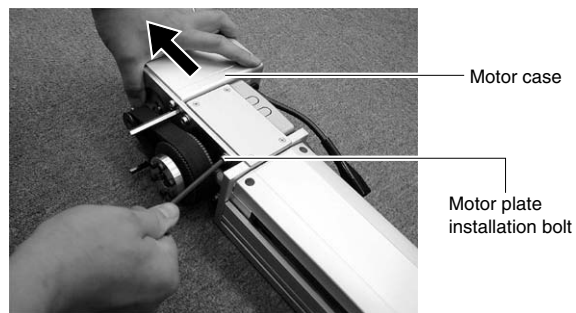
- 3) Detach the belt from the pulley. Change the motor orientation as desired, and temporarily tighten the four motor plate installation bolts. At this point, set the motor case toward the belt loosening side.



- 4) First attach the belt to the small pulley, and then fit it onto the large pulley.



- 5) Temporarily fix the motor plate installation bolts while pulling on the motor case.



- 6) Refer to “Chapter 11 7-1-2. Adjusting the speed reduction belt tension” and adjust the belt tension.

- 7) Install the belt cover.

CAUTION

Confirm that the large pulley teeth and belt teeth are correctly engaged. Positional deviation or premature belt damage could occur if the teeth are not sufficiently engaged.

6 Installing the Cover

If the X-axis stroke is long, a slider mechanism is provided in the X-axis stroke cover. The alignment of the slider and upper cover must be adjusted when installing the cover.

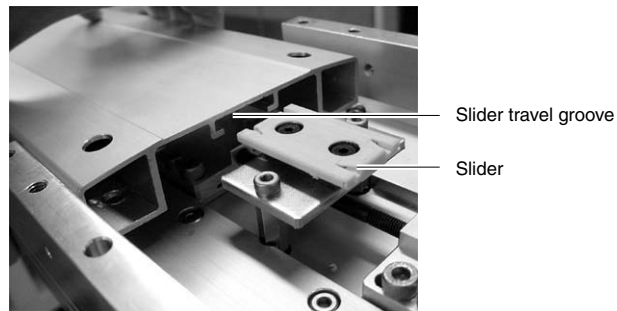
Target FXYBX X stroke 2150mm or more
 SXYBX X stroke 2450mm or more

CAUTION

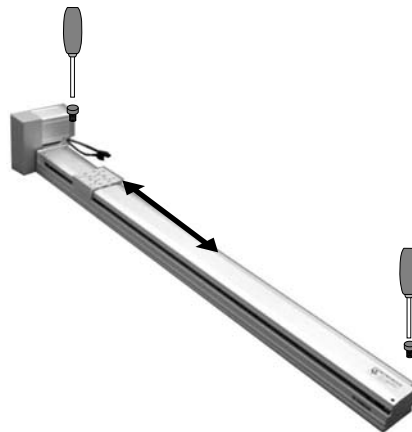
If the slider and upper cover are not correctly adjusted, the slider could be damaged prematurely.

When inserting into the U-character groove, take care not to cut the slider with the edge of the cover.

- 1) Turn the controller power OFF.
- 2) Insert the slider into the U-character groove on the center of the upper cover. Set the upper cover so that it is parallel with the axis movement direction at this time.



- 3) Temporarily fasten the four upper cover installation screws, move the table from the motor side to the counter-motor side end, and then completely tighten the screws on the counter-motor side. Move the table to the motor side again, and then completely tighten the two upper cover installation screws on the motor side.



- 4) Move the slider by hand to check that it travels along the upper cover smoothly.

7 Adjusting the Timing Belt Tension

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts, turn the controller power OFF, wait for a while and check that the part has cooled.

⚠ WARNING

There is a risk of injury if fingers, etc., are caught between the drive section pulley and belt. Always turn the controller power OFF and carefully carry out the work if these parts may be contacted.

⚠ CAUTION

The position will deviate when the belt tension is adjusted. Carry out return-to-origin or absolute reset, and reset the point data.

The X-axis and the Y-axis for the FXYBX and SXYBX use a timing belt to drive the slider.

If the timing belt tension is weak, adjust the belt tension with the following procedures.

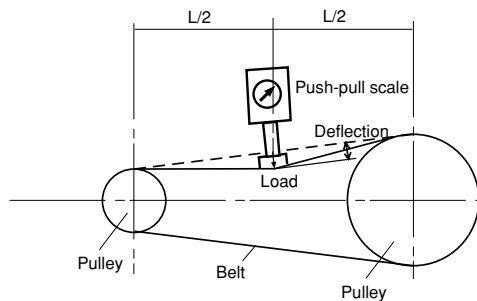


Fig. 11-19 Adjusting the speed reduction belt tension

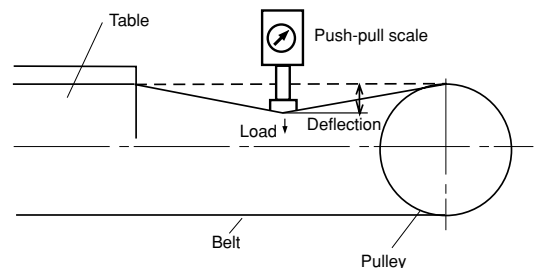


Fig. 11-20 Adjusting the drive belt tension

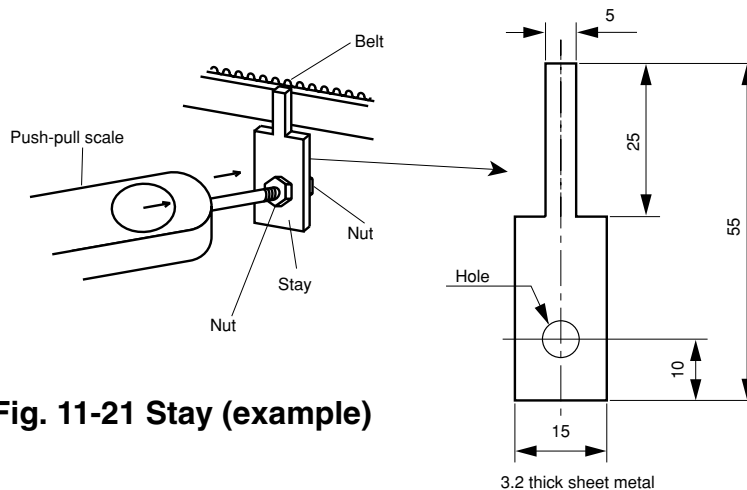


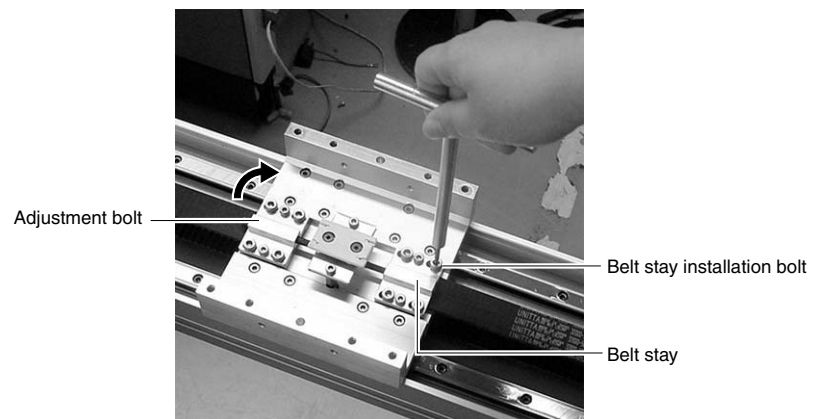
Fig. 11-21 Stay (example)

7-1

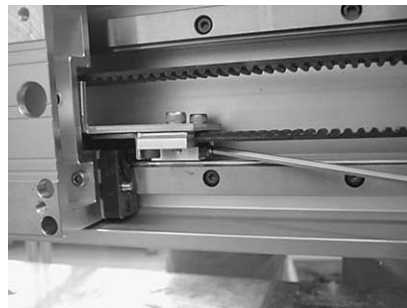
Adjusting the drive belt tension**CAUTION**

On robot models having a long stroke, a slider is provided in the upper cover. Pull off the upper cover with a parallel movement in the axis movement direction.

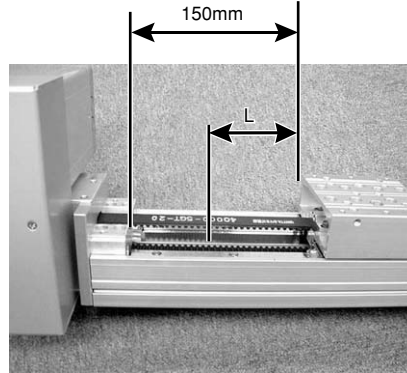
- 1) Turn the controller power OFF.
- 2) Remove the end cover.
- 3) Remove the upper cover installation screws, and remove the upper cover.
- 4) FXYBX X-axis, SXYBX X, Y axes
Attach the enclosed belt tension adjustment bolt, and loosen the eight belt stay installation bolts. Turn the enclosed adjustment bolt to apply tension on the belt.

**FXYBX Y-axis**

Loosen the belt holder fixing bolt (on slot side), and turn the adjustment bolt to apply tension on the belt.



- 5) Move the slider by hand so that the distance between the slider end face and base block end face is 150mm. Apply a load at the L = 115mm position from the base block end for the FXYBX X-axis, at L = 65mm for the FXYBX Y-axis, and L = 129mm for the SXYBX X and Y axes.



- 6) Temporarily tighten the belt stay installation bolt. If the deflection is within the range shown in Table 11-1 when the belt is pressed with the designated load, the tension is appropriate. If the deflection is not within the range of Table 11-1, repeat steps 4) and 5) to adjust the tension.

Table 11-1 Drive belt load and deflection

| Model | Load (N) | Load (kgf) | Deflection(mm) |
|----------------------|------------|------------|----------------|
| FXYBX X-axis | 4.9 to 5.9 | 0.5 to 0.6 | 2 |
| FXYBX Y-axis | 5.9 to 6.9 | 0.6 to 0.7 | 2 |
| SXYBX X-axis, Y-axis | 5.9 to 6.9 | 0.6 to 0.7 | 2 |

- 7) Tighten the belt stay installation bolt, and remove the belt tension adjustment bolt.
- 8) Refer to “Chapter 11 6. Installing the Cover”, and install the upper cover. Finally, install the end cover.

Reference

(Adjusting the drive belt tension with a tension meter)

Use of a belt tension gauge is recommended to obtain more accurate measurements.

Recommended tension meter U-505 (UNITTA)

Measurement method

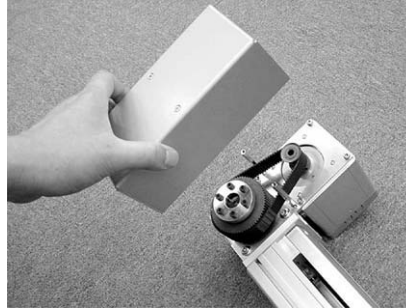
In step 5) of the adjustment of the drive belt tension, pull the belt at the position where the load is applied, and adjust to the following values.

Refer to the instruction manual enclosed with each measuring instrument for details on using the belt tension gauge.

| Model | Tension (N) | Frequency (Hz) | Span length (mm) | Belt width (mm) | Unit weight (g/mm width×m length) |
|----------------------|-------------|----------------|------------------|-----------------|-----------------------------------|
| FXYBX X-axis | 127 to 147 | 86 to 93 | 230 | 20 | 4.0 |
| FXYBX Y-axis | 127 to 147 | 117 to 126 | 170 | 20 | 4.0 |
| SXYBX X-axis, Y-axis | 169 to 188 | 79 to 84 | 258 | 25 | 4.0 |

7-2 Adjusting the speed reduction belt tension

- 1) Turn the controller power OFF.
- 2) Remove the end cover.

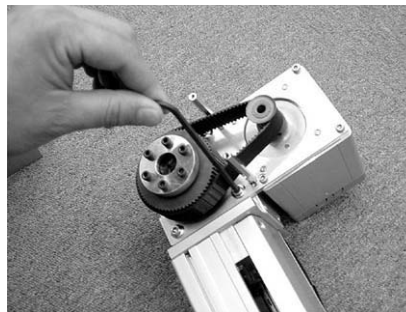


- 3) Apply the load listed in Table 11-2 at the center of both pulleys, and measure the deflection at that point. If the results are within the range given in Table 11-2, the tension is suitable.

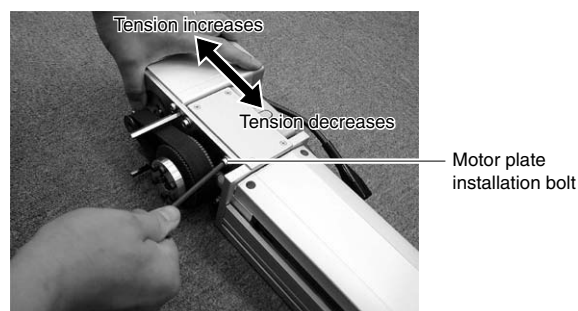
Table 11-2 Speed reduction belt load and deflection

| Model | Load (N) | Load (kgf) | Deflection (mm) |
|----------------------|------------|-------------|-----------------|
| FXYBX X-axis | 5.9 to 6.9 | 0.6 to 0.7 | 3 |
| FXYBX Y-axis | 3.9 to 4.6 | 0.4 to 0.47 | 3 |
| SXYBX X-axis, Y-axis | 5.9 to 6.9 | 0.6 to 0.7 | 3 |

- 4) If adjustments are required, loosen the motor plate installation bolt.



- 5) If the value measured in step 3) is less than Table 11-2, move the motor case in the direction to increase the tension. If larger than the values given in Table 11-2, move the motor case in the direction to decrease the tension.



- 6) Measure the belt tension again with the procedure given in step 3). The belt adjustment is completed if the measured value is within the range given in Table 11-2. If the measured value is not within the range of Table 11-2, repeat steps 3) to 5).
- 7) Tighten the motor plate installation bolt.
- 8) Install the belt cover.

Reference

(Adjusting the speed reduction belt tension with a tension measuring instrument)

Use of a belt tension gauge is recommended to obtain more accurate measurements.

Recommended tension gauge U-505 (UNITTA)

Measurement method

In step 3) of the adjustment of the speed reduction belt tension, pull the belt at the position where the load is applied, and adjust to the following values.

| Model | Tension (N) | Frequency (Hz) | Span length (mm) | Belt width (mm) | Unit weight (g/mm width × m length) |
|----------------------|-------------|----------------|------------------|-----------------|-------------------------------------|
| FXYBX X-axis | 44 to 49 | 180 to 190 | 82 | 20 | 2.5 |
| FXYBX Y-axis | 29 to 34 | 180 to 190 | 88.5 | 12 | 2.5 |
| SXYBX X-axis, Y-axis | 44 to 49 | 180 to 190 | 82 | 20 | 2.5 |

8 Periodic inspections

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

8-1 Replacing the motor

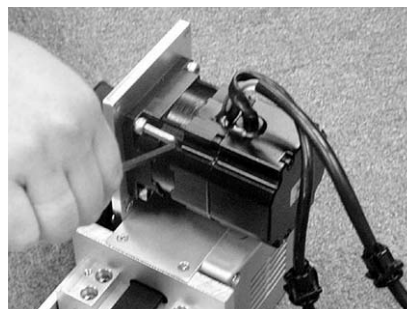
⚠ CAUTION

The position will deviate when the motor is replaced. After replacing the motor, return-to-origin must be carried out and the point data must be reset. Remember the relation of the installation positions when removing any parts.

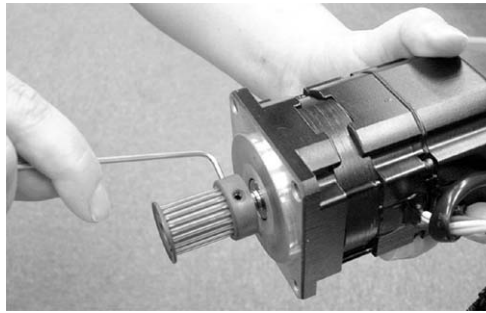
- 1) Turn the controller power OFF.
- 2) Remove the belt cover.
- 3) Remove the motor case and motor cover.



- 4) Remove the four motor installation bolts, and remove the motor.



- 5) Loosen the two pulley set screws, and remove the pulley.



- 6) Replace the motor, and attach the pulley to the motor. Insert so that the two set screws perpendicularly contact the D face of the motor shaft.

NOTE

The parts can be correctly assembled by projecting the set screws by approx. 0.1 to 0.2mm from the inner diameter.

- 7) Install the motor onto the main body.
- 8) Attach the belt.
- 9) Refer to “Chapter 11 7. Adjusting the Timing Belt Tension” and adjust the belt tension.
- 10) Install the motor case and cover.
- 11) Install the belt cover.

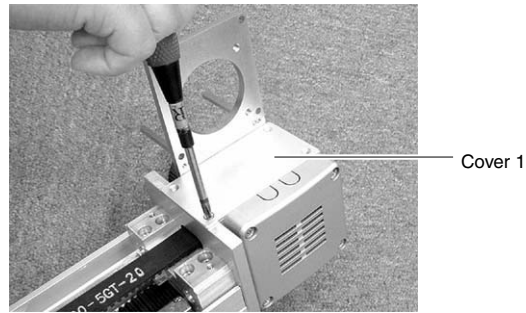
8-2 Replacing the drive belt

CAUTION

The position will deviate when the belt is replaced. After replacing the belt, return-to-origin must be carried out and the point data must be reset. Remember the relation of the installation positions when removing any parts.

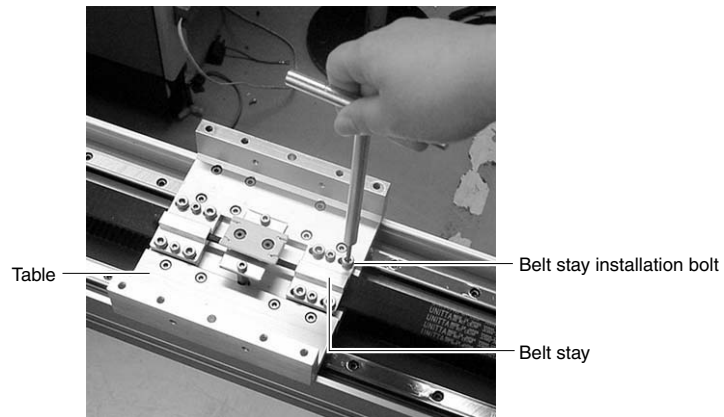
- 1) Remove the end cover from the counter-motor end, and remove the upper cover. (On robot models having a long stroke, pull off the upper cover with a parallel movement in the axis movement direction.)
- 2) Refer to “Chapter 11 8-1. Replacing the motor”, and remove the motor. (This step is not required if the motor is installed at horizontal position or lower position.)

- 3) Remove cover 1.



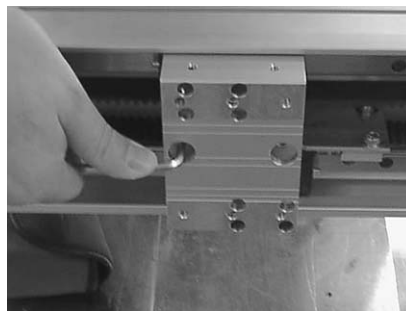
- 4) FXYBX X-axis, SXYB X, Y axes

Remove the belt stay installation bolts (4 bolts, 2 stays), and remove the belt stays from the table.



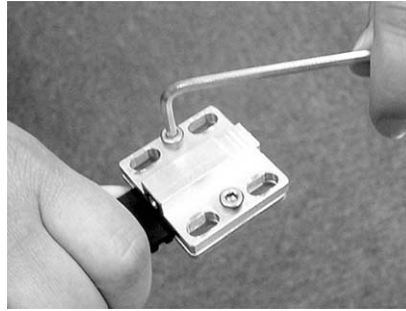
FXYBX Y-axis

Remove the two belt stay installation bolts, and remove the belt stay from the table.

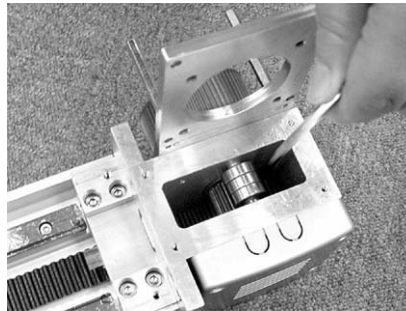


- 5) Remove the belt stay bolts (2 bolts, 2 stays), and remove the belt.

- 6) Attach the new belt.



- 7) First, lead the belt from the top of the idle pulley, and push it out with a narrow rod, etc.
- 8) Next, lead the belt through the lower side of the slider and lead it to below the drive pulley. Use a narrow rod, etc., to face the belt edge upwards.



- 9) Finally, mesh the belt between the drive pulley and drive pulley idler, and turn the drive pulley.
- 10) Attach the belt stays to the belt.
- 11) Install the belt stays onto the slider table, and temporarily tighten the belt stay installation bolts.
- 12) Refer to “Chapter 11 7. Adjusting the Timing Belt Tension”, and adjust the belt tension.
- 13) Refer to “Chapter 11 6. Installing the Cover”, and install the upper cover.
- 14) Install the end cover.

8-3 Replacing the speed reduction belt

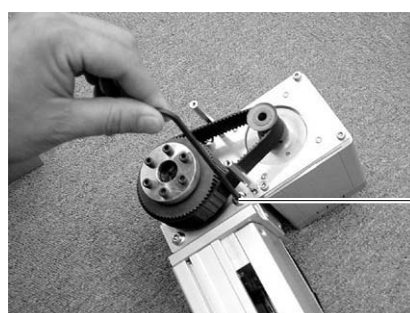
CAUTION

The position will deviate when the belt is replaced. After replacing the belt, return-to-origin must be carried out and the point data must be reset. Remember the relation of the installation positions when removing any parts.

- 1) Remove the belt cover.



- 2) Remove the four motor plate installation bolts.

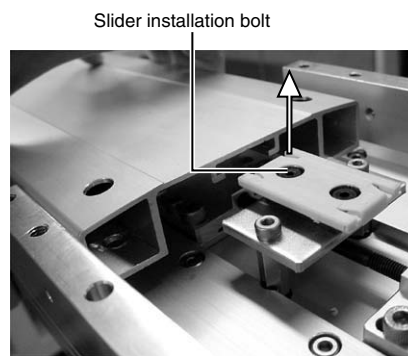


- 3) Place the motor plate near the loose side, and remove the belt.
- 4) First, attach the new belt to the small pulley, and then fit it onto the large pulley.
- 5) Refer to “Chapter 11 7-1-2. Adjusting the speed reduction belt tension”, and adjust the tension.
- 6) Install the belt cover.

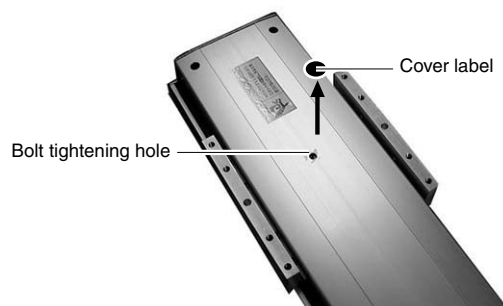
8-4 Replacing the slider

If the X stroke is 2150mm or more for the FXYBX, or 2450mm or more for the SXYBX, a slider mechanism is provided in the X-axis stroke cover. Use the following procedure if the slider needs to be replaced due to wear or damage.

- 1) Turn the controller power OFF.
- 2) Pull off the upper cover with a parallel movement in the axis movement direction.
- 3) Remove the two slider installation bolts.



- 4) Replace the slider, and temporarily tighten the two installation bolts.
- 5) Refer to "Chapter 11 6. Installing the cover", and install the upper cover.
- 6) Move the table two or three times along the full stroke.
- 7) Remove the 12mm diameter label attached to the upper cover on the counter-motor side, and move the slider until the slider installation bolt is visible from this hole.



- 8) Tighten the slider installation bolts, and move the table again by approx. 20mm. Then, tighten the other slider installation bolts.
- 9) Attach the enclosed label to plug the hole.

8-5 Replenishing the grease

8-5-1 Replenishing grease to the linear guide

The X-axis, Y-axis and Z-axis (ZF) use a linear guide as the linear guide mechanism. Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

CAUTION

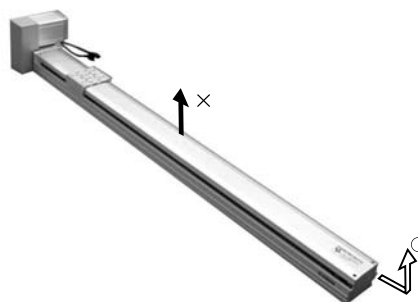
When the ZF unit is attached for the 3rd-axis, the replenishment work can be carried out easier by moving the Z-axis slider to near the motor (near the origin) and turning the controller power OFF.

CAUTION

If the X-axis stroke is 2150mm or more for the FXYBX, or 2450mm or more for the SXYBX, a slider mechanism is provided in the X-axis stroke cover to support the inner self-weight.

When removing the X-axis stroke cover, do not pull it up and off. Instead, pull it with a parallel movement in respect to the axis movement direction, to remove the stroke cover from the slider. Then, pull it upward and off.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the axis stroke cover when replenishing grease.



- 4) Using a grease gun, replenish grease from the grease nipple installed on the linear guide bearings.

Sufficient grease has been replenished when new grease starts to seep out from the clearance between the linear guide bearings and rail.

FXYBX

X-axis, Y-axis

The X-axis has four bearings, and the Y-axis has two linear guide bearings. Replenish grease to all bearings. Wipe off any excessive grease that has seeped out to the rail.

Recommended grease gun : MG70 (THK) N-type nozzle

SXYBX

X-axis, Y-axis

The X-axis and Y-axis each have four linear guide bearings. Replenish grease to all four bearings.

Wipe off any excessive grease that has seeped out to the rail.

Recommended grease gun : MG70 (THK) N-type nozzle

Z-axis (ZF)

One linear guide bearing is attached. A grease nipple is attached to the counter-motor side of the slider, so move the slider to the motor side and then start the work.

Recommended grease gun : MG70 (THK) H-type nozzle

- 5) Install the stroke cover.

Confirm the surrounding safety, and then turn the controller power ON.

8-5-2 Replenishing grease to the ball screw (ZF)

The ZF uses a ball screw for drive. Grease must be periodically replenished to the ball screw. Refer to section 8-6. for details on replenishing grease to the ZS/ZRS unit ball screw. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

CAUTION

Always remove the grease nipple after completing the work. Damage or positional deviation could occur if the robot is operated with the grease nipple installed.

- 1) Prepare the following recommended grease nipple beforehand.

Recommended grease nipple : A-M6X1 type (JIS B1575)

- 2) Turn the controller power OFF.

NOTE

The replenishment work can be carried out easier by moving the Z-axis slider to near the motor (near the origin) and turning the controller power OFF.

- 3) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 4) Remove the axis stroke cover when replenishing grease. (Refer to "1. Installation" for details on removing the cover.)
- 5) Install the grease nipple onto the ball screw flange.
- 6) Replenish the grease from the grease nipple using the grease gun.
Sufficient grease has been replenished when new grease starts to seep out from the clearance between the ball screw nut and screw. Wipe off any excessive grease.

Recommended grease gun : MG70 (THK) N-type nozzle

- 7) Remove the grease nipple.

8-6 Periodic inspection of the ZS/ZRS unit

8-6-1 Replenishing grease to the Z-axis ball screw and ball spline

A ball screw drive is used for the ZS and ZRS vertical axis. Grease must be replenished to this ball screw periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the screws (M4, 6 screws) fixing the cover, and pull the cover upward and off.

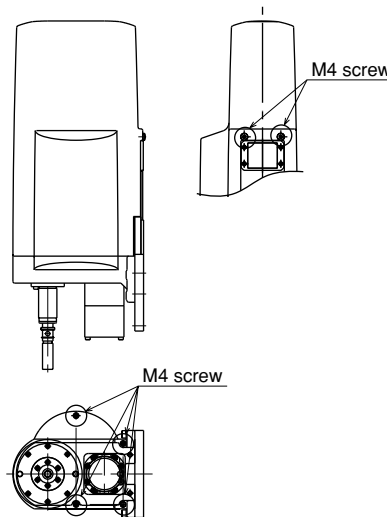


Fig. 11-22 ZS

- 4) Wipe off any excessive grease adhered on the ball screw shaft and ball spline shaft.
- 5) Apply a thin coat of grease on the screw shaft with a finger.
- 6) Return the cover to the original position.

8-6-2 Adjusting the R-axis belt tension (ZRS)

⚠ WARNING

There is a risk of injury if fingers, etc., are caught between the drive section pulley and belt section. Always turn the controller power OFF and carefully carry out the work if these parts may be contacted.

⚠ CAUTION

The position will deviate when the belt tension is adjusted. Carry out absolute reset, and reset the basic coordinates and point data.

With the ZRS model, a timing belt is used for the R-axis.

If the timing belt tension is weak, adjust the belt tension with the following procedures.

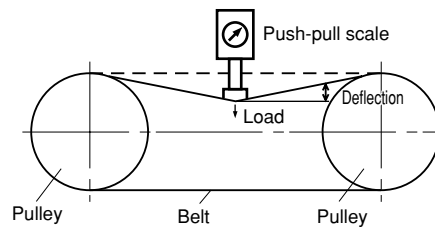


Fig. 11-23 Adjusting the belt tension

- 1) Turn the controller power OFF.
- 2) Place a sign indicating "Work In Progress" so that other operators do not turn the controller power ON.
- 3) Remove the cover. (M4, 6 screws)
- 4) The following work must be carried out by two operators.
One operator must apply a vertical load on the center of the belt with the push-pull scale, and the other operator must measure the belt deflection at that time.
- 5) If the measured value is within the range shown below, there is no need for adjustment. Adjust with the following procedure if the measured value is not within the range.

Table 11-3

| | |
|-------------------|---------------------------------|
| Load | 4.4 to 4.8N (0.45 to 0.49kgf) |
| Deflection amount | 2mm |

- 6) Loosen the M4 bolt ① (three positions) shown in Fig. 11-24.

- 7) If the value measured in step 4) is smaller than the value given in Table 11-3, move the R-axis motor so that the tension increases. If larger than the value in Table 11-3, move the R-axis motor so that the tension decreases. Then, fix the bolts.
- 8) Measure the belt tension again with the procedure given in step 4).

If the measured value is within the range shown in Table 11-3, adjustment of the R-axis belt tension is completed. If the measured value is not within the range shown in Table 11-3, repeat steps 6) to 8) and adjust.

- 9) Tighten the M4 bolt ① with the specified tightening torque.
Specified torque 4.5N·m (46kgf·cm)
- 10) Return the cover to the original position.

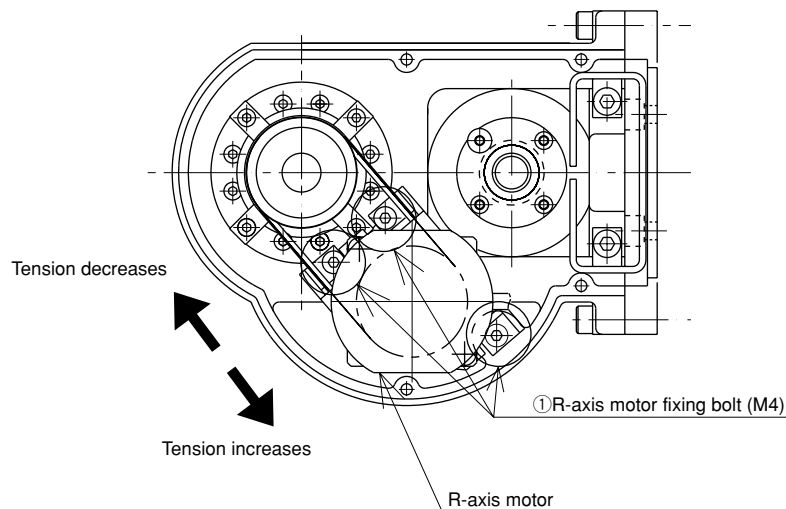


Fig. 11-24 ZRS belt tension

8-6-3 Replacing the R-axis harmonic drive (ZRS)

The ZRS R-axis speed reduction gear uses a harmonic drive.

The ZRS uses a harmonic drive as the R-axis speed reduction gear, which must be replaced after using for a set period. Determine the harmonic drive replacement period with the following procedure, and replace as required.

The ZRS harmonic grease uses a long-life type, and the grease does not need to be replaced.

Replacement period

The harmonic drive replacement period is determined by the total number of wave generator rotations. A calculation example is shown below.

The recommended harmonic drive replacement period is 8.4×10^8 rotations (at usage atmospheric temperature range 0°C to $+40^\circ\text{C}$).

The harmonic drive should be replaced earlier if the robot operation duty is high or if the temperature conditions are poor.

$$[\text{Replacement period}] = 8.4 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta) \text{ years}$$

n : Number of robot movements in one minute
 θ : Average axis rotation in one movement
 N : Deceleration rate (50 for ZRS R-axis)
 h : Number of operation hours per day
 D : Number of operation days per year

(Example) The YK500X X-axis harmonic drive replacement period when the axis rotates an average quarter turn every movement and the robot moves ten times in one minute. (Operation hours: 24 hours/day, number of operation days: 240 days/year)

n : 10
 θ : 0.25
 N : 50
 h : 24
 D : 240

$$[\text{Replacement period}] = 8.4 \times 10^8 / (n \times 60 \times h \times D \times N \times \theta)$$

$$= 8.4 \times 10^8 / (10 \times 60 \times 24 \times 240 \times 50 \times 0.25)$$

$$= 19.4 \text{ years}$$

Consult with YAMAHA when actually replacing the harmonic drive.

MEMO

CHAPTER 12

HXYLX

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1 Installation

⚠ WARNING

Always turn the controller power OFF before installing the robot. Serious accidents might occur if the robot starts to operate during installation.

Install the HXYLX by tapping holes into the installation base and securing the robot to the base with M8 bolts from the inside of the robot. The installation method is the same for the arm type, pole type, moving arm type and gantry type X-axis. Note that the installation method differs for the gantry type support axis.

1-1 Installation method 1 (Arm type, moving arm type, pole type, gantry type X-axis)

Install the arm type, moving arm type, pole type and gantry type X-axis in the following manner.

1-1-1 Installation bolt types

- Use the following type of installation bolt.
Hexagon socket head cap screw M6 Strength 8.8T

1-1-2 Installation bolt nominal length

⚠ WARNING

Do not use washers or spring washers with the tightening bolt. The bolt head could interfere with the linear guide's bearings and be damaged.

If the installation base is made of steel, secure 1D or more (8mm or more for M8) for the screw fitting length. When made of aluminum, secure 1.5D or more (12mm or more for M8).

The frame thickness is 33mm. (Refer to Fig. 12-1.)

Recommended nominal length 45mm or more

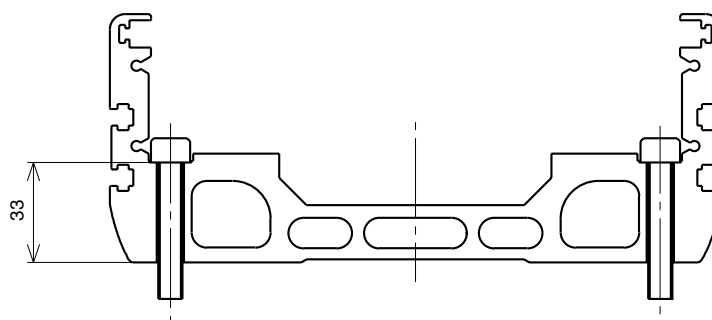


Fig. 12-1

1-1-3 Tightening torque

- The accurate tightening torque will differ according to the seating face frictional coefficient and the female screw material, etc. The following tightening torque is recommended as a guide.

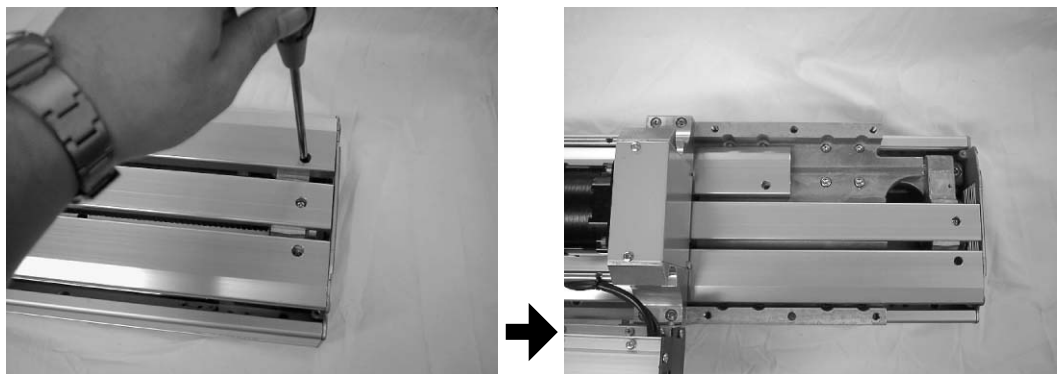
Recommended torque 22.5N·m to 36.3N·m (230kgf·cm to 370kgf·cm)

1-1-4 Installation methods

⚠ WARNING

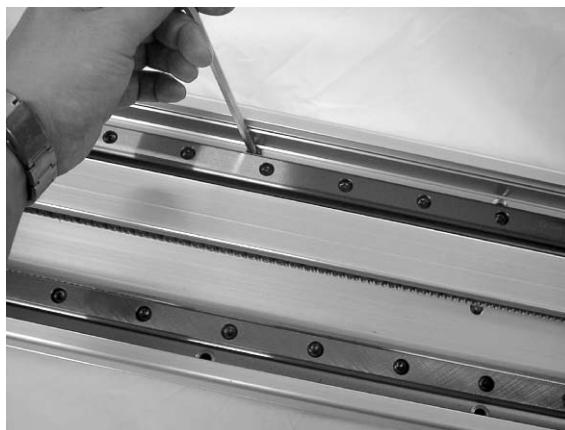
Always use the designated bolt, and securely tighten it with the correct torque. Failure to observe this could cause the robot position to deviate, and could also lead to serious accidents.

- 1) Tap M8 coars screw thread holes into the installation base where the robot is to be installed.
Refer to the XY-X Series catalog for the hole positions.
- 2) Remove the screws securing the upper cover of the robot and remove the upper cover.
If necessary, move the slider to a location where it does not block the installation holes on the bottom of the robot frame.



- 3) Secure the robot to the base with the specified bolts and torque.
The bolts and tightening torque are shown below.

| | |
|-------------------|--|
| Bolt | Hex socket-head M8 bolt, strength: 8.8T, length: longer than 45mm (F17), longer than 50mm (F20) |
| Tightening torque | 230kg-cm to 370kg-cm |

**⚠ WARNING**

Be sure to tighten the bolt to the correct torque. The wrong torque may not only cause robot position errors but also lead to serious accidents.

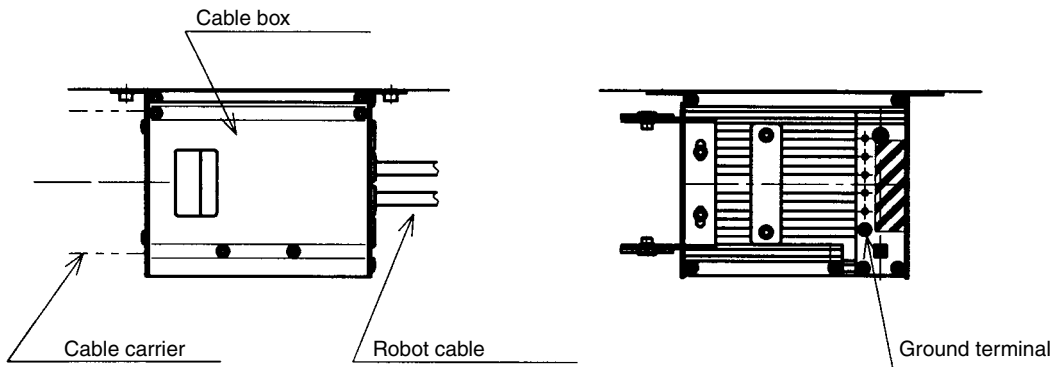
- 4) Reattach the upper cover after installing the robot.
Refer to Chapter 12 “5-5 Installing and removing the cover”, and install the cover.

●Protective bonding

⚠ WARNING

Always ground the robot and controller unit to prevent electrical shock.

A grounding terminal (M4 screw) is provided inside the cable box, so always ground the unit. The position of the grounding terminal is shown below.



⚠ CAUTION

- A secure ground connection (less than 100-ohm resistance to ground) is recommended.
- Use electrical wire thicker than AWG14 (2mm²) as the ground wire.

⚠ WARNING

Always turn off the power to the controller before making the ground connection.

Provide a terminal marked “PE” as the protective conductor for the entire system, and connect it to an external protective conductor. Also securely connect the ground terminal on the robot frame to the protective conductor.



(Symbol 417-IEC5019)

1-2 Installation method 3 (Gantry type support axis)

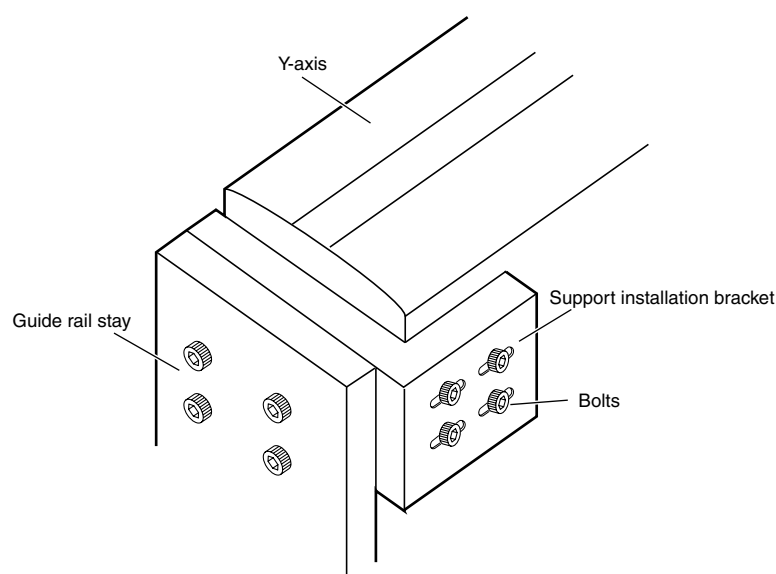
Install the gantry type support axis in the following manner.

CAUTION

Move the X-axis as much as possible, and tighten the bolts where the movement is the lightest.

Set the X-axis and guide rail parallelism during installation. Make sure that there is no difference in the height direction of the X-axis and guide rail installation surface.

- 1) **Fix the robot onto the specified position of the installation base with bolts.**
Do not tighten the guide rail bolt at this time. Securely fix the X-axis section onto the installation base.
- 2) **When the ZR-axis is provided, or if tools are already attached, move as close to the X-axis side as possible so that a load is not applied on the guide rail.**
- 3) **Loosen the bolt for the Y-axis and support installation bracket. (Refer to following drawing.)**
- 4) **Temporarily fix the guide rail onto the installation base with bolts.**
The parallelism of the guide rail and X-axis must be set using a dial gauge or pick gauge, etc.
- 5) **To easily set the parallelism, first tighten the bolt loosened in step 3).**
Set the X-axis near one end, and tighten the bolt on the guide rail end in this state. Next, move the X-axis to the opposite end, and tighten the bolt on the opposite side of the guide rail in this state. Repeat this until all bolts have been tightened.



Adjustment of gantry type support rail

2 Protective Connections

⚠ WARNING

Always ground the robot and controller to prevent electrical shocks.

⚠ WARNING

Always turn the controller power OFF before connecting the ground to prevent electrical shocks.

⚠ WARNING

When using a tool or workpiece having power which could contact the robot due to a failure or the specifications, the user must provide proper grounding since the robot does not have a ground terminal for those devices.

Refer to the following explanations and connect the robot side ground tap with the external protective conductor's ground terminal using a ground wire.

2-1 Ground terminal

The ground terminal is located on the inside of the X-axis wiring box. (Refer to Fig. 12-3.)

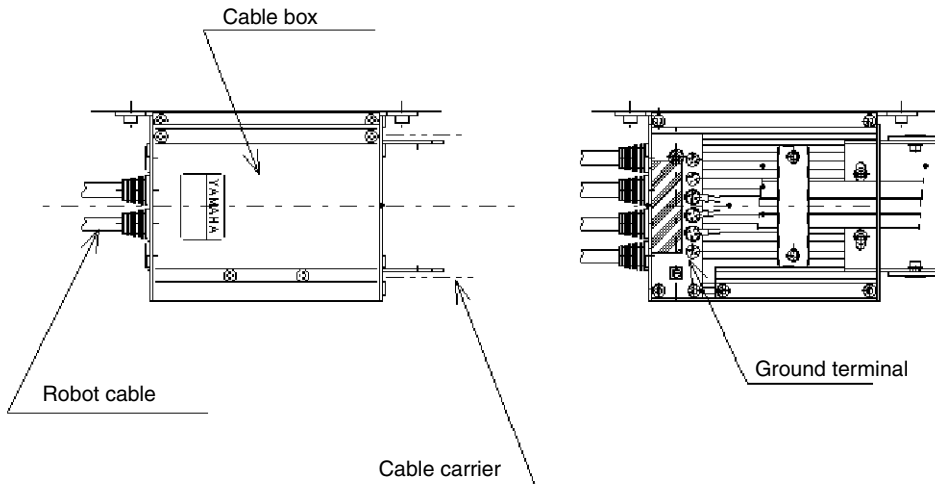


Fig. 12-3

2-2 Ground wire

Use an AWG14 (2.0mm²) or larger ground wire with a total length of 1m or less. Crimp an M4 ring-tongue terminal on the end of the wire connected to the robot.

2-3 Wiring methods

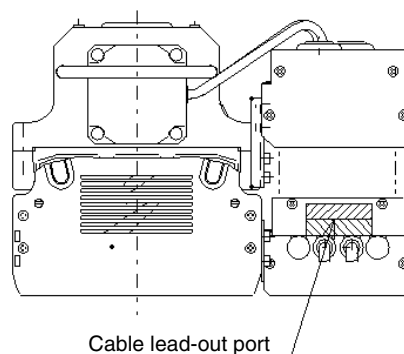
⚠ CAUTION

Accurately insert the lock washer between the ring-tongue terminal and robot. Proper continuity may not be secured if the lock washer is dislocated.

- 1) Loosen the four M4 small screws, and open the X-axis wiring box cover.



- 2) Pass the ground wire through the cable lead-out port on the X-axis wiring box (fixed).



- 3) Connect the ring-tongue terminal of the ground wire to the ground terminal on the robot.

An M4 small screw with spring washer and lock washer are attached to the ground terminal. Arrange the parts in the order of the lock washer, ring-tongue terminal and M4 small screw with spring washer, and then tighten. (Refer to Fig. 12-4.)

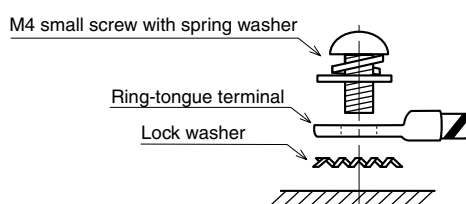


Fig. 12-4

3 Installing the Tool

Install the user tool onto the robot's tool installation surface in the following manner.

⚠ WARNING

Always turn the controller power OFF before installing a tool to prevent an accident.

⚠ WARNING

Before installing a tool, check that the robot is securely fixed to the base.

⚠ WARNING

The user is responsible for determining the required bolt type and tightening torque, and accurately installing the tool. Improper installation can cause the tool to dislocate during operation and lead to serious accidents.

3-1 Arm type, gantry type 2-axis model

Eight M8 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider installation surface. (Refer to Fig. 12-5.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

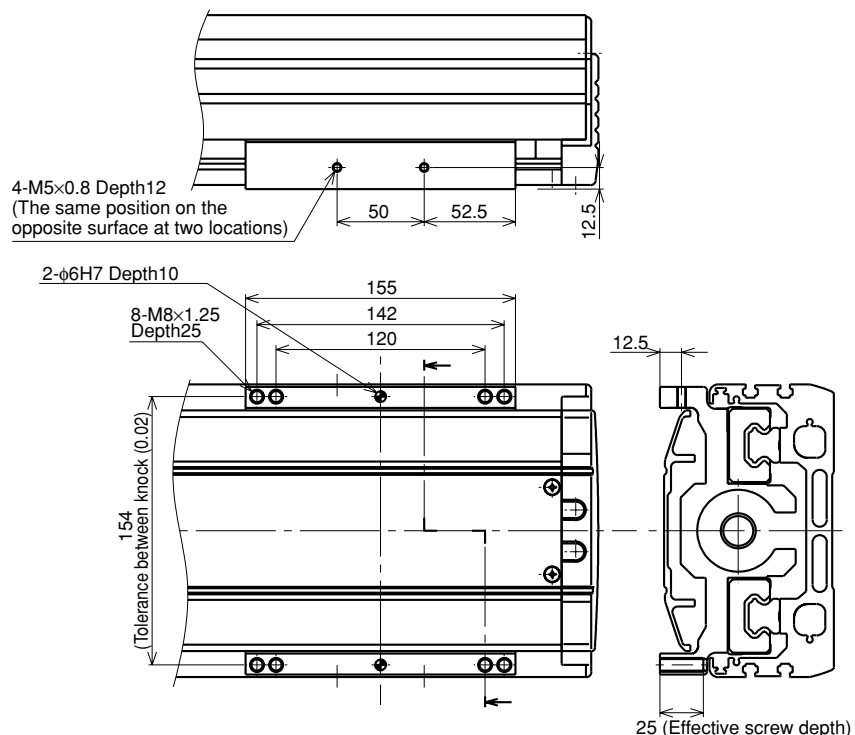


Fig. 12-5 HXYLX arm type, gantry type

Select the nominal length of the tool fixing bolt so that the fitting length of the screw fixing the tool is 16mm or more, 25mm or less. (Refer to the cross-section drawings in Fig. 12-5.)

CAUTION

If the fitting length is less than 16mm, the threads could be damaged during tightening. Note that if the fitting length exceeds 25mm, the bolt end could contact the cover.

3-2 Moving arm type 2-axis model

The moving arm type has an aluminum-cast bracket on the end of the Y-axis. Install the tool on this bracket.

Twelve M8 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the bracket.

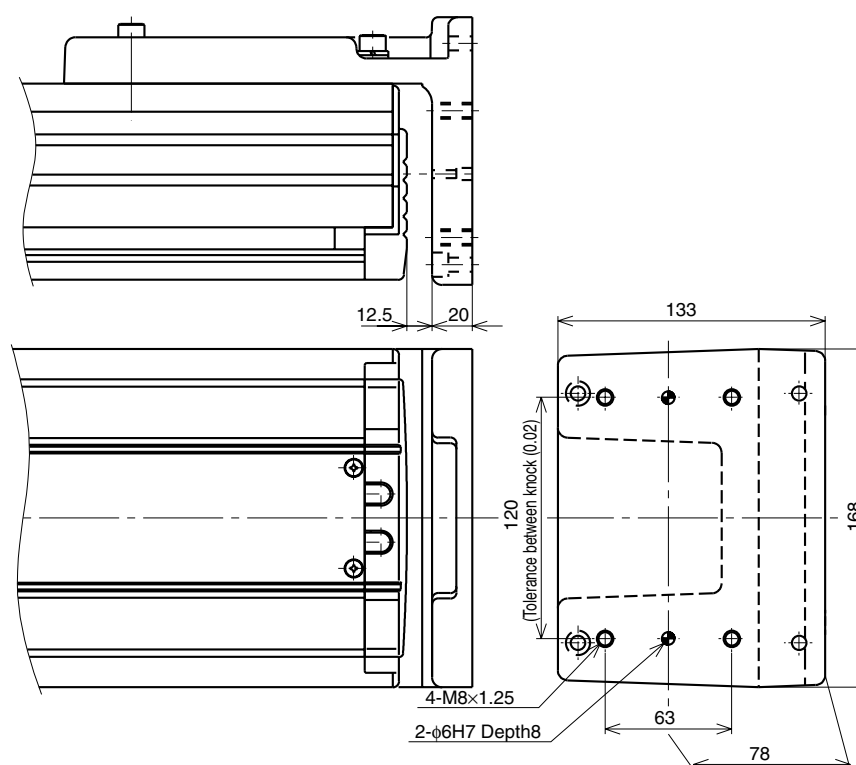


Fig. 12-6 HXYLX moving arm type

Select the minimum fixing bolt screw length so that the screw fitting length is 16mm or more.

CAUTION

If the fitting length is less than 16mm, the threads could be damaged during tightening. If the fitting length is longer than 30mm, the screw could contact the Y-axis.

3-3 Pole type 2-axis model

Four M8 coarse thread tap holes and two $\phi 8$ reamer holes are opened on the tool installation surface of the Y-axis slider. (Refer to Fig. 12-7.) Install the user tool onto the Y-axis slider using these holes.

Four M5 coarse thread tap holes are also opened on the slider side. Use these to fix light loads other than the tool, such as a wiring retainer.

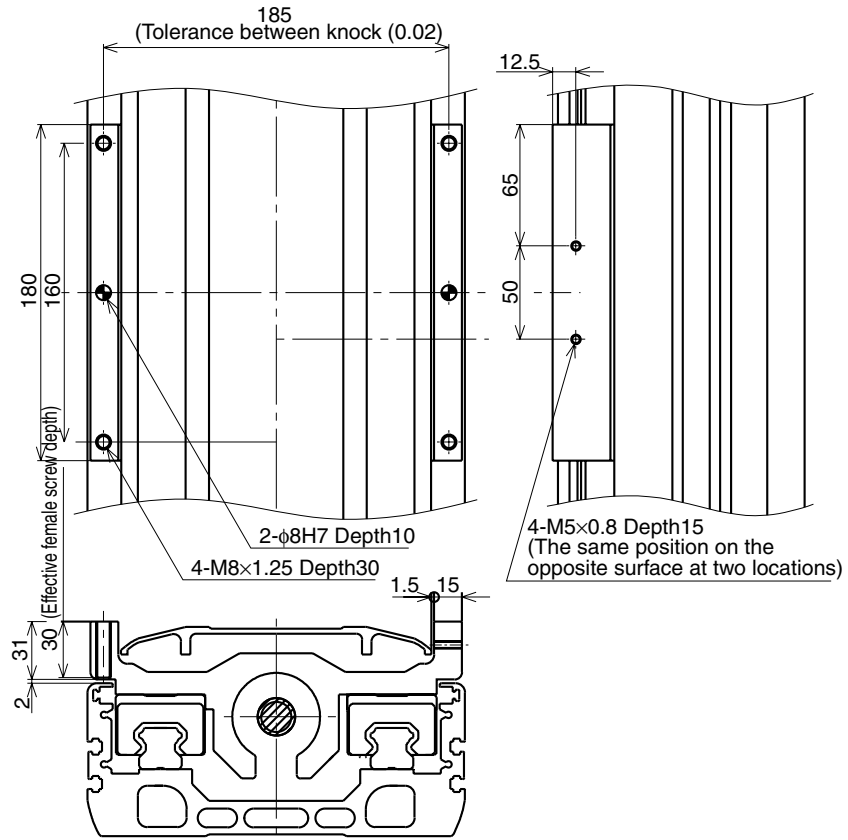


Fig. 12-7 HXYLX pole type

Select the under head length of the bolt fixing the tool so that the screw length from the slider installation surface is 16mm or more, 30mm or less.

CAUTION

If the screw's fitting length is less than 16mm, the screw threads could be damaged during tightening. If the screw length from the installation surface is longer than 30mm, the screw end could contact the frame.

3-4

ZH**(Arm type, gantry type, moving arm type 3rd-axis option)**

When using the 3rd-axis model with ZH for the 3rd-axis, install the workpiece onto the ZH frame in the following manner.

M6 coarse thread tap holes are opened on the frame's workpiece installation surface. Install the tool using these holes. The tap depth is 10mm.

Select the under head length of the installation bolt so that the screw length from the installation surface is 9mm or more, 27mm or less.

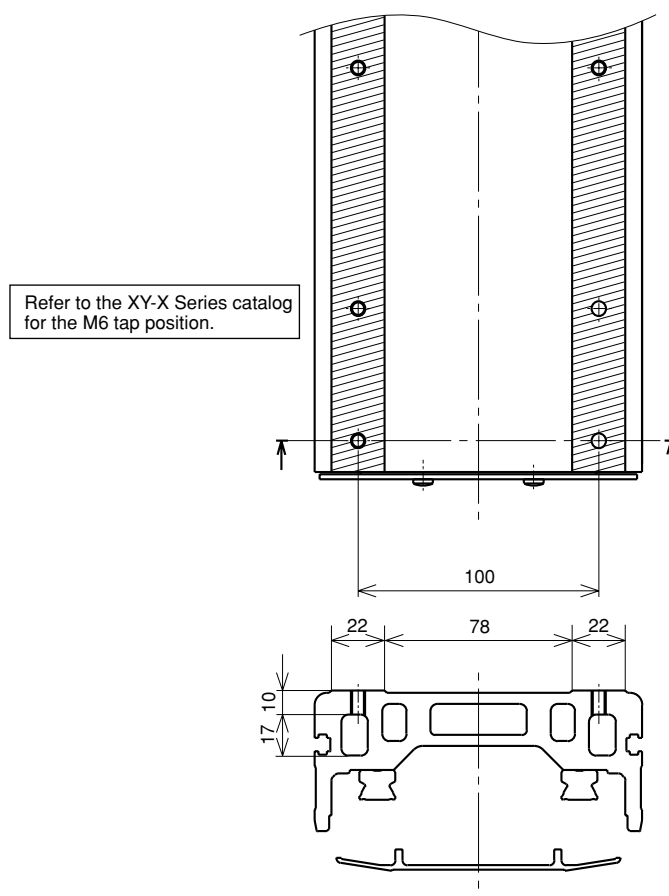


Fig. 12-8 Tool installation ZH

NOTE

There is a step on the ZH frame.

The actual tool installation surface is the shaded section shown above.

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the screw length exceeds 27mm from the installation surface, the screw could contact the bottom.

3-5 ZL (Arm type, gantry type)

When using the 3rd-axis model with ZL for the 3rd-axis, install the workpiece onto the ZL slider in the following manner.

Eight M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the Y-axis slider. (Refer to Fig. 12-9.) Install the user tool onto the ZL slider using these holes.

Four M5 coarse thread tap holes are opened on the side of the slider. Use these to fix loads other than the tool, such as the wire retainer.

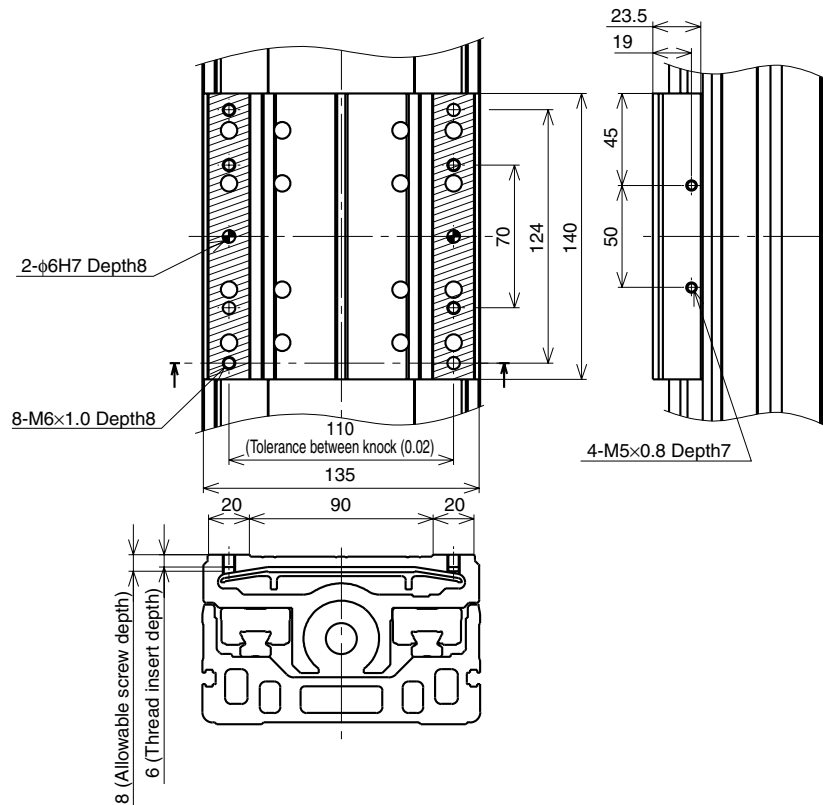


Fig. 12-9 ZL

NOTE

There is a step on the top of the slider. The actual tool installation surface is the shaded section shown above.

Select the nominal length of the bolt for fixing the tool so that the screw fitting length is 6mm or more, 8mm or less. (Refer to the cross-section drawing in Fig. 12-9.)

CAUTION

If the fitting length is less than 6mm, the threads could be damaged during tightening. If the fitting length is longer than 8mm, the end of the screw could contact the cover stroke.

3-6 ZPH (Pole type 3rd-axis option)

When ZPH is attached for the 3rd-axis of the pole type, install the tool onto the aluminum bracket at the end of the ZP-axis.

Twelve M6 coarse thread tap holes and two $\phi 6$ reamer holes are opened on the bracket.

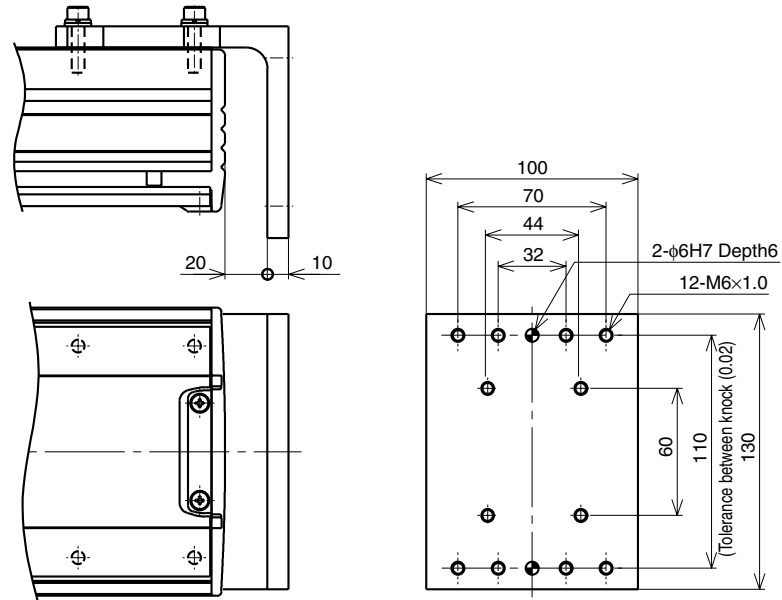


Fig. 12-10 ZPH

Select the minimum nominal length of the fixing bolt so that the length is 9mm or more from the tool installation surface.

CAUTION

If the fitting length is less than 9mm, the threads could be damaged during tightening. If the bolt screw length exceeds 30mm from the installation surface, the screw could contact the Y-axis.

3-7 RH (Arm type, gantry type 4th-axis option)

CAUTION

When fixing with the tap holes, always fix at several holes. If fixed with only one hole, the loosening torque could act during operation can cause loosening.

If the rotary axis RH is attached to the 4th-axis, install the tool onto the shaft at the end of RH.

Five M8 coarse thread tap holes are opened on the end of the shaft. Install the tool using these holes. The tool can also be installed with a bolt coupling or split clamp using the outer diameter of the shaft.

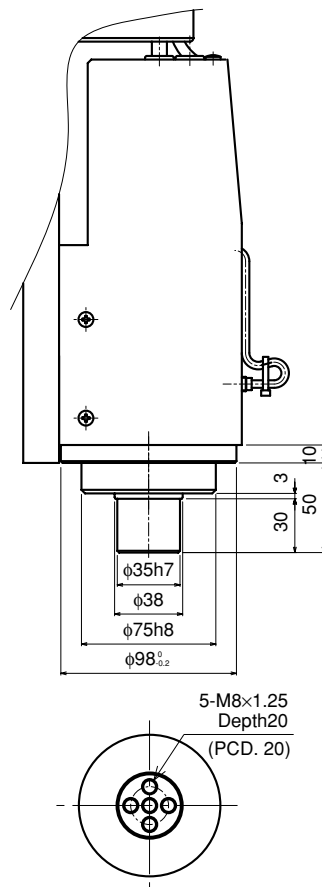


Fig. 12-11 RH

NOTE

The $\phi 75$ section shown below is the non-movable section. The rotary shaft is the section below $\phi 38$.

4 User Wiring and User Piping

⚠ WARNING

Always turn off the controller before wiring and piping to prevent electrical shocks.

4-1 Cable carrier type

A cable carrier is mounted as a standard between the X and Y axes. When 3rd-axis are used, a cable carrier is also provided between the Y and Z axes, and when using 4th-axis, a cable carrier is also provided between the Z and R axes. Lay the wiring and piping to the tool using these ducts. A 0.3sq 10-core flexible cable is wired from the X-axis wiring box to the final axis wiring box, and can be used freely. The wiring and piping methods for a 2-axis arm type are explained below as an example.

4-1-1 Example of wiring and piping methods using cable carrier

- 1) Remove the four M4 small screws and open the X-axis wiring box (fixed) cover.



- 2) Pass the required cables and air tubes, etc., through the cable lead-out port on the X-axis wiring box (fixed).

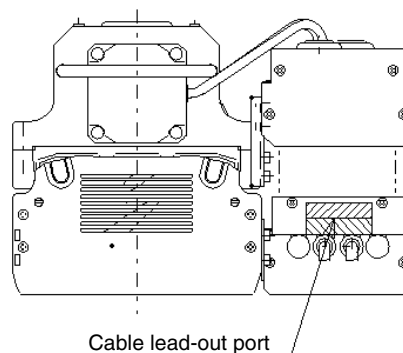
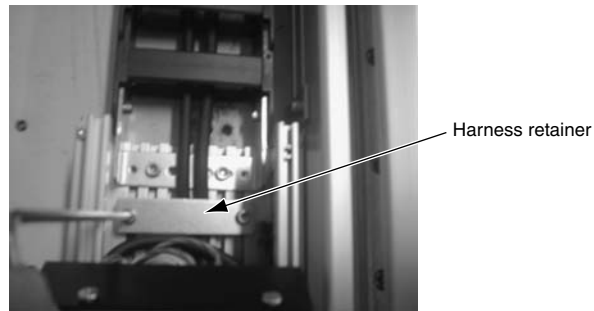


Fig. 12-12

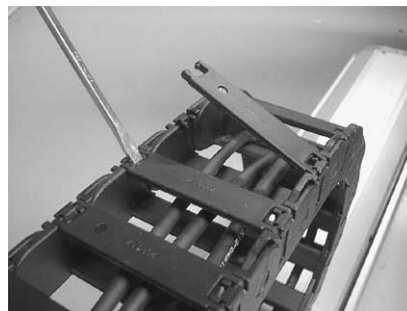
- 3) Remove the harness retainer located at the cable carrier outlet. (Hexagon socket bolt M5, 2 bolts)



- 4) Pass the required wires and pipes through the cable carrier.



The cable carrier has an outer lid that can be opened and closed easily. Use a flat-tip screwdriver to open the lid. Press this lid in to close it.



- 5) Open the cover of the X-axis wiring box (movable), and lay the required wiring and piping.
- 6) **CAUTION** _____
 1. The wires could be damaged if the harness retainer is tightened too much.
 2. Manually move the robot by the full stroke before fixing to confirm that the harness and air tube, etc., are not pulled in the cable carrier. These could be damaged if pulled during operation.

When completed with the wiring, fix with the harness retainer in the wiring box.

- 7) **CAUTION** _____

Take care not to catch the harness or air tube with the cover.

Return each wiring box cover to the original position.

4-1-2 Cable carrier specifications

CAUTION

When setting the harness and air tube into the cable carrier, make sure that the total cross-sectional area of all wires and pipes, including the YAMAHA cable, inside the cable carrier does not exceed 30% of the cable carrier's cross-sectional area. (This ratio is called the cable carrier space factor.)

The cross-sectional shape of the cable carrier, and the shape of the cable mounted initially by YAMAHA are shown below.

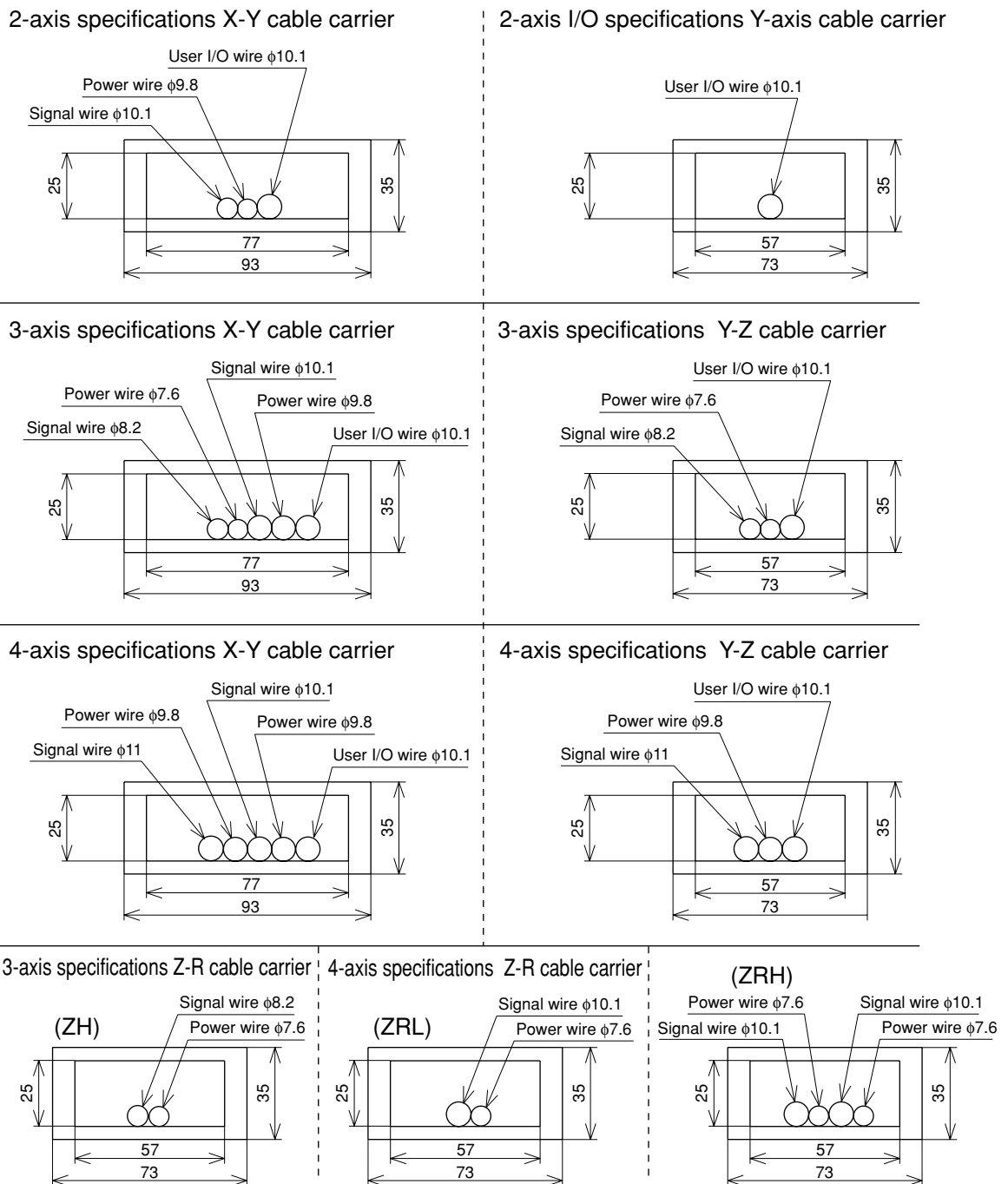


Fig. 12-13

4-1-3 User I/O cable specifications

▲ CAUTION

Securely crimp the pin and insert into the pin connector.
Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

With the cable carrier specifications, signal wires ($0.3\text{mm}^2 \times 10$ wires) that can be used freely by the user are laid as a standard between the X-axis wiring box and final axis' wiring box.

Connectors and pins fitted onto the connectors on both ends of this signal wire are also enclosed. Attach these to the user wiring to eliminate wiring led through the robot.

Crimp the enclosed pins onto the user wiring, and insert into the connector.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

Refer to “1-2. User I/O wiring” in Chapter 5 “Specifications” for details on the wiring specifications.

4-2 Whipover cable type (moving arm type/pole type 3-axis)

⚠ CAUTION

Do not clamp the wires or tubes to the outside of the independent cable. The independent cable could sag or break and ultimately be disconnected.

The signal wires ($0.3\text{mm}^2 \times 7$ wires) and air tubes (4×2.5 , 2 tubes) are incorporated in the Whipover cable. Use these to wire and pipe to the tool.

| Part No. | Part name | Part No. | Qty. |
|----------|--------------|----------------|------|
| 1 | SM connector | SMR-10V-B | 1 |
| 2 | SM connector | SMP-10V-BC | 1 |
| 3 | Contact | SYM-001T-0.6 | 7 |
| 4 | Contact | SHF-001T-0.8BS | 7 |
| 5 | Cable | | 1 |

| Signal | Connector | NO | NO | Connector | Remarks |
|---------------------|-----------|----|----|-----------|-------------|
| General-purpose I/O | I/O ① | 1 | | 1 | I/O ② Brown |
| | | 2 | | 2 | Red |
| | | 3 | | 3 | Orange |
| | | 4 | | 4 | Blue |
| | | 5 | | 5 | Purple |
| | | 6 | | 6 | Gray |
| | | 7 | | 7 | White |
| | | 8 | | 8 | |
| | | 9 | | 9 | |
| | | 10 | | 10 | |

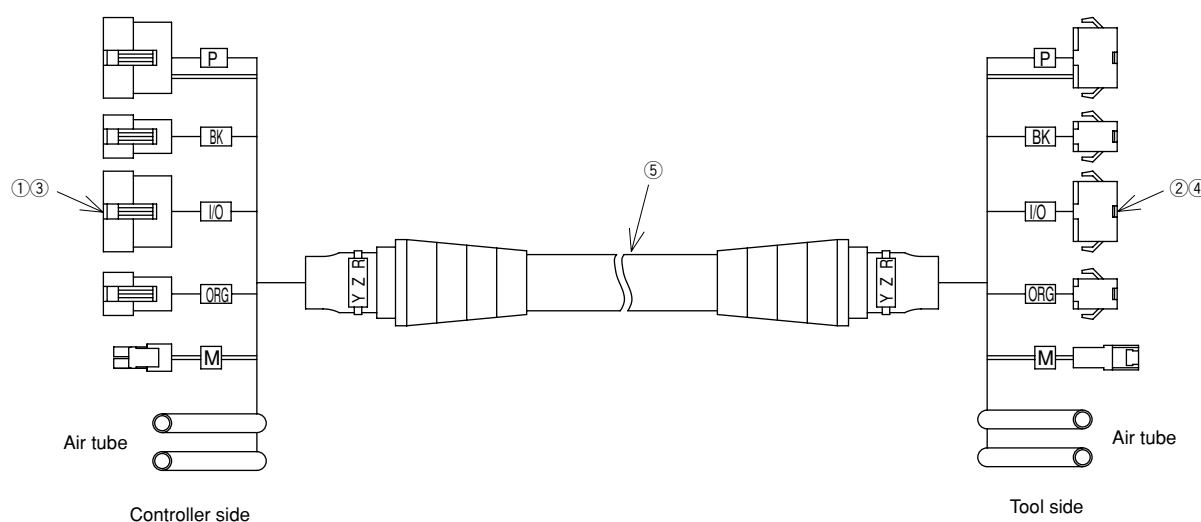


Fig. 12-14 Whipover cable user-wire specifications

4-2-1 Examples of wiring and piping with Whipover cable

⚠ CAUTION

Securely crimp the pin and insert into the pin connector. Failure to do so will prevent the signals and power from being supplied correctly, and may prevent the device from operating correctly.

- 1) Crimp the user's cable and tool wiring onto the enclosed connector. Refer to section "1-2. User I/O wire" in Chapter 5 "Specifications" for details on the enclosed connector and pin specifications.

Recommended crimping tool YC-122R (J.S.T. Mfg Co., Ltd.)

- 2) When using an air tube, prepare an air coupler for connecting the user air tube with the YAMAHA air tube.

- 3) Open the X-axis wiring box (movable) cover.

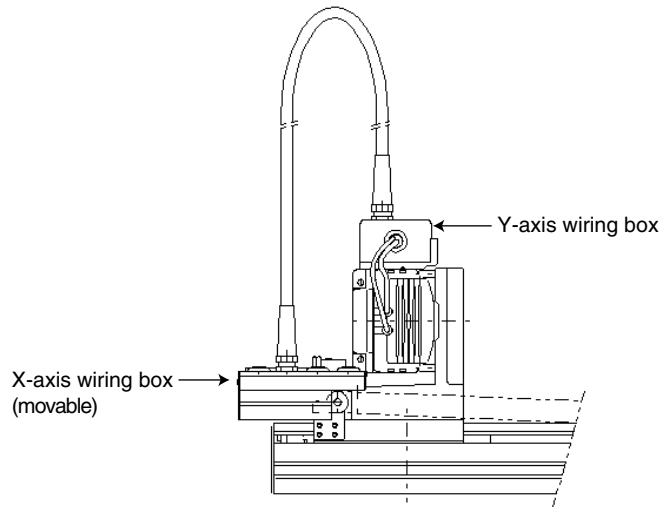


Fig. 12-15

- 4) Pass the required cables and air tubes, etc., through the X-axis cable conduit. Crimp the enclosed connectors onto the cable.
- 5) Connect the connectors, and connect the air tubes using the air couplers.
- 6) Open the Y-axis wiring box cover.
- 7) Rubber grommets are also attached to the Y-axis wiring box. Open holes in these grommets, and pass the tool side cables and air tubes through.
- 8) Connect the connectors in the same manner as the X-axis, and connect the air tubes with the air couplers.

- 9) **CAUTION**

Take care not to catch the wiring or air couplers when installing the covers.

When completed with all wiring work, return each wiring box cover to the original positions. Sandwich the X-axis wiring and air tube with the protective material at the wire lead-out port of each wiring box.

5 Periodic Inspections

⚠ WARNING

Always turn the controller power OFF before starting periodic inspections. Serious accidents could occur if the robot starts moving during the periodic inspection.

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts, turn OFF the controller, wait for a while and check that the part has cooled.

The inspection periods and general precautions are described in Chapter 4 Periodic Inspections. Always refer to that Chapter before starting this work.

5-1 Replenishing grease to the linear guide

Grease must be replenished to this linear guide periodically. Select the grease from the following recommended types.

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

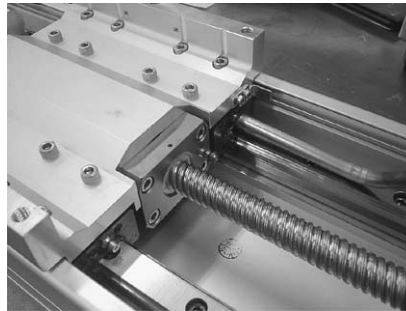
⚠ CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

- 1) Turn the controller power OFF.
- 2) Place a sign indicating “Work In Progress” so that other operators do not turn the controller power ON.
- 3) Remove the axis stroke cover when replenishing grease.
Refer to section “1. Installation” for details on opening the X-axis stroke cover.

- 4) Replenish the grease with one of the following methods.

Method 1: Using a grease gun, replenish grease from the grease nipple installed on the linear guide bearings.



Sufficient grease has been replenished when new grease starts to seep out from the clearance between the linear guide bearings and rail.

The X-axis and Y-axis each have four linear guide bearings. Replenish grease to all four bearings.

Wipe off any excessive grease that has seeped out to the rail.

Recommended grease gun: MG70 (THK X-axis, Y-axis H-type nozzle)
(THK Z-axis (ZL) N-type nozzle)

Method 2: After wiping off the grease adhered on the rail and on the bearing seal section with a rag, etc., apply a light coat of grease directly onto the guide rail with a finger.

NOTE

Due to the structure of ZH, grease can be replenished only with this method.

When replenishing grease to ZH, turn the power OFF when near the center of the stroke, and then apply grease to the top and bottom of the guide.

- 5) Return the stroke cover to the original position.

5-2 Replenishing grease to the ball screw

Prepare the following recommended grease nipple beforehand.

Recommended grease nipple : A-M6X1 type (JIS B1575)

Recommended grease : Alvania No. 2 (Showa Shell)
Daphne Eponex No. 2 (Idemitsu)

CAUTION

When designated by YAMAHA and the user, special grease, such as splatter-proof grease, may be applied when the robot is delivered. In this case, apply the appropriate grease as indicated in the delivery specification drawings, etc.

Replenishment methods

Refer to the following procedures and replenish the grease.

- 1) Remove the stroke cover of the axis to which grease is to be replenished.
- 2) Replenish the grease with one of the following methods.

CAUTION

Always remove the grease nipple after replenishing the grease. Failure to do so could cause damage if the grease nipple and robot interfere.

Method 1: Install the grease nipple onto the M6 tap hole on the ball screw flange surface, and replenish grease using the grease gun.



Sufficient grease has been replenished when new grease starts to seep out to the screw shaft.

Wipe off any excessive grease.

Recommended grease gun : MG70 (THK H-type nozzle)

Method 2: Wipe off any grease adhered on the ball screw with a rag, etc., and directly apply grease into the ball screw slit with a finger.

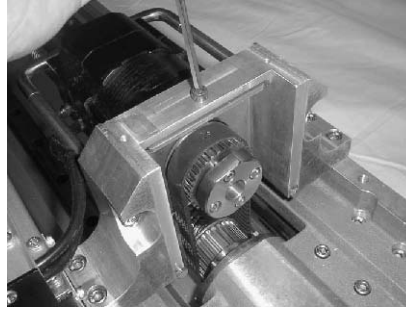
NOTE

Due to the structure, the X-axis and ZH can be greased only with this method.

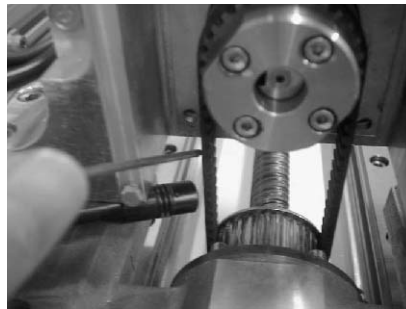
- 3) Return the stroke cover to the original position.

5-3 Adjusting the timing belt tension (X-axis)

- 1) Temporarily tighten the motor installation bolt.
- 2) Remove the belt cover, and install the adjustment bolt (M5). Apply belt tension. (Refer to the following photograph.)



- 3) Tighten the motor fixing bolt.
- 4) As shown below, place the measuring instrument's head near the belt, and pull the center of the belt span with a hexagon wrench, etc.



- 5) Refer to the following table, and adjust the belt tension.

| Frequency (Hz) | Tension (N) | Tension (kg) | Span length (mm) | Belt unit weight (kg/m) |
|----------------|-------------|--------------|------------------|-------------------------|
| 207 to 219 | 88 to 98 | 9 to 10 | 100 | 0.051 |

- 6) When the appropriate tension has been set, tighten the motor installation bolt, and measure the tension again. (Note that the tension will increase as the bolt is tightened.)
- 7) Remove the adjustment bolt, and install the belt cover.

5-4 Replacing the motor (X-axis)

CAUTION

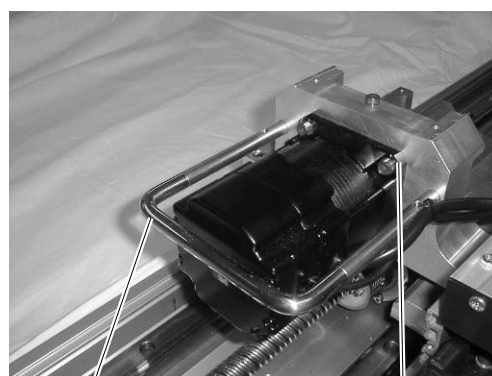
Since a positional shift occurs after replacing the motor, return-to-origin must be performed again and the point data re-specified. When removing the parts, check and mark the part positions versus each other so you can correctly reassemble the parts later.

- 1) Turn the controller power OFF.
- 2) Remove the belt cover and motor cover.
- 3) Open the cover of the box fixed onto the table slide, and disconnect the motor wiring connector.
- 4) Remove the motor installation bolts (M6: four bolts).



Wiring box

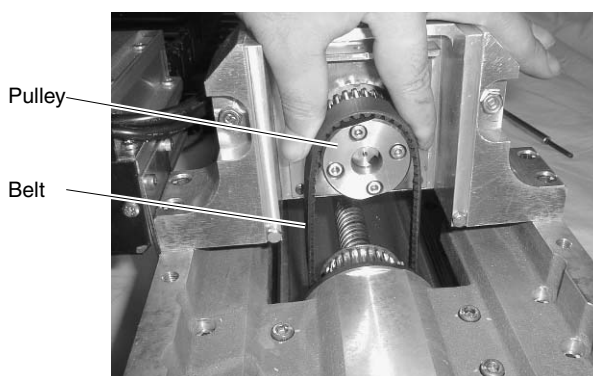
Motor cable



Motor cover

Motor installation bolt

- 5) Pull the belt off the pulley. (Refer to the following photograph.)

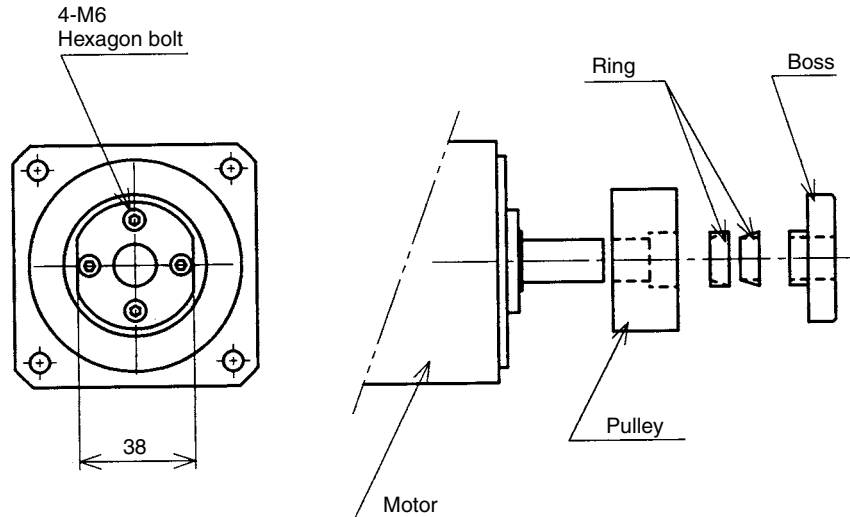


Pulley

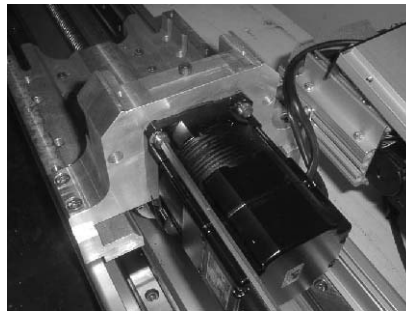
Belt

- 6) Remove the motor.

- 7) Remove the fixing bolts (M6: four bolts) from the pulley connection boss, and pull the pulley off the motor.
(Loosen the bolts while fixing the surface machined section of the boss with a pair of pliers, etc.)



- 8) Replace the motor, and install the pulley onto the motor. (Refer to the photograph above.) Take care to the orientation and order of the rings at this time.
- 9) Install the motor onto the block. Temporarily tighten the fixing bolts.



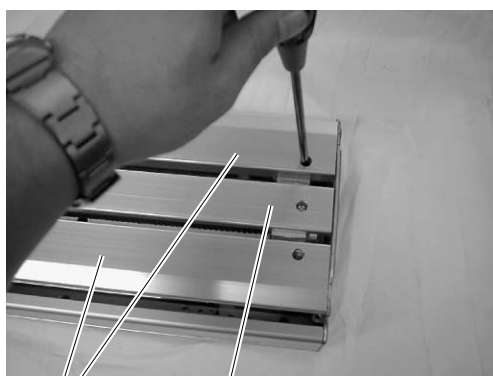
- 10) Install the belt.
Refer to section “5-3 Adjusting the timing belt”, and adjust the belt tension.
- 11) Install the motor cover and belt cover.
- 12) Connect the motor wiring connector, store inside the box, and install the cover.

5-5 Installing and removing the cover

5-5-1 Stroke cover

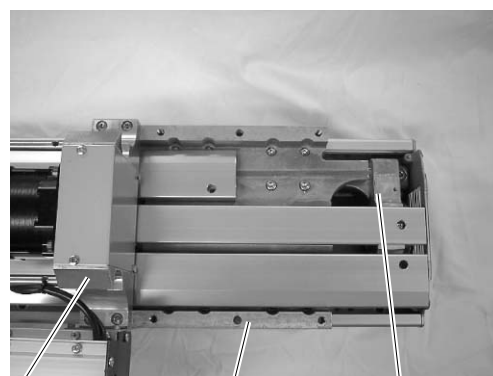
Removing the stroke cover

- 1) Remove the fixing screws (M4, pan-head) on both ends.
- 2) Place the table slide near the stroke end, and pull off the cover.



Side cover

Center cover



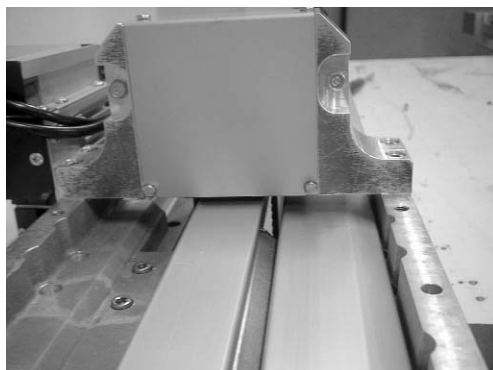
Motor block

Table slide

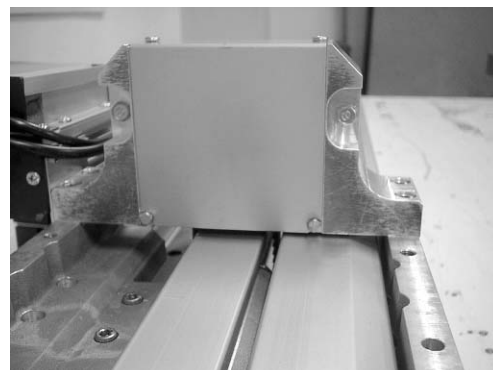
End block

Installing the stroke cover

- 1) Place the table slide near the stroke end, and pass the cover between the table slide and motor block.
- 2) Fix the cover to the end block. At this time, move the table slide to the stroke center, and confirm that it does not interfere with the cover. If the table slide interferes with the cover, adjust by tightening the cover fixing screw. (Refer to following photographs.)



When cover contacts table slide
⇒ Tighten the cover fixing screw

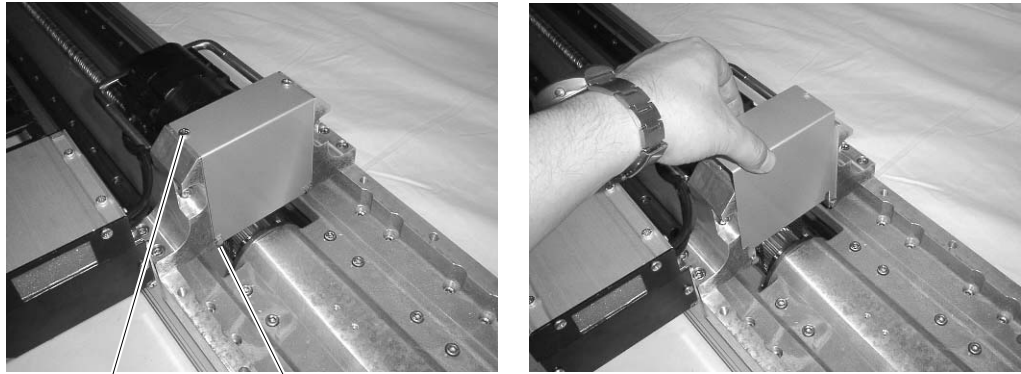


When cover contacts motor block
⇒ Loosen the cover fixing screw

5-5-2 Belt cover

Removing the belt cover

- 1) Loosen the hexagon bolts (M4, two bolts) on the front with a spanner or socket wrench. After removing the M4 screws on the top, pull the cover upward and off. (Refer to the following photograph.)



M4 screw (two screws) M4 hexagon bolt (two bolts)

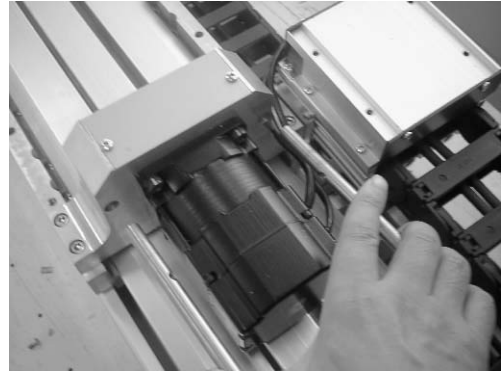
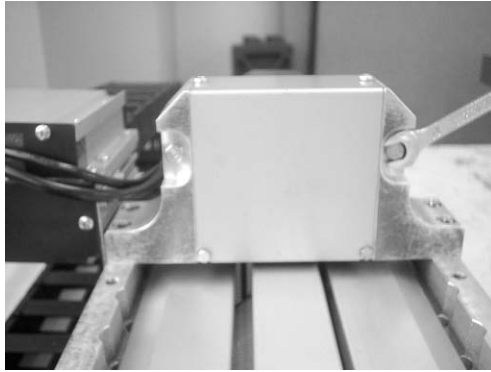
Installing the belt cover

- 1) Fit the cover so that the notch on the cover passes between the hexagon bolts. Tighten the hexagon bolts with a spanner or socket wrench, and then fix from above with the M4 screws.

5-5-3 Motor cover

Removing the motor cover

- 1) Cut the Insulock-tie binding the motor cable with a pair of nippers, and remove.
- 2) Remove the two M6 hexagon bolts, and pull the motor cover upward and off. (Refer to the following photograph.)



Installing the motor cover

- 1) Insert the motor cover into the installation hole, and fix with two M6 hexagon bolts.
- 2) Using the $\phi 5$ hole open on the motor cover, fix the motor cable with an Insulock-tie.

OWNER'S MANUAL

YAMAHA **XY-X** *SERIES*
Cartesian robot

Oct. 2006

Ver. 1.08

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